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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXII.—No. 2918.] *LONDON: FRIDAY, DECEMBER 2, 1921.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 4d.

Aveling & Porter, Ltd., ROCHESTER. 9097
Steam Road Rollers & Tractors.

A. G. Mumford, Ltd., CULVER STREET WORKS, COLCHESTER.
On Admiralty and War Office Lists.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement pages 29 and 75.
PATENT WATER-TUBE BOILERS, AUTOMATIC FEED REGULATORS,
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, LTD., Friars House, 39-41, New Broad St., LONDON, E.C.2.
See half-page Advert. last week and next week. 9389

Cranes.—Electric, Steam, HYDRAULIC and HAND, of all types and sizes.
GEORGE RUSSELL & CO., LTD., Motherwell, near Glasgow. 9109

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited, BIRMINGHAM 7411
See Advertisement last week, page 99.

S. Sokal, CHARTERED PATENT AGENT.
1, Great James Street, Bedford Row, London, W.C.1. T.N. 4515 Museum. 9075

Tank Locomotives. Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., Engineers, Newcastle-on-Tyne. 9105

Cochran Boilers. MULTITUBULAR AND CROSS-TUBE TYPES.
See page 17. 9108

Petter Oil Engines. For Paraffin and Crude Oil. Sizes 2½ B.HP. and upwards.
Petters Limited, Yeovil. Sizes 25 to 500 B.HP.
Vickers-Petters, Ltd., Ipswich
See advertisement alternate weeks. 9335

Invincible Gauge Glasses.
BUTTERWORTH BROS., Ltd., Newton Heath Glass Works, Manchester. Od 9753

Electric Transporters.
S. H. HEYWOOD & CO., LTD., REDDISH. 9026

Fuller, Horsey, Sons & Cassell. SPECIALISTS in the SALE AND VALUATION of PLANT AND MACHINERY and ENGINEERING WORKS.
11, BILLITER SQUARE, E.C.3. 1834

Iron and Steel
Tubes and Fittings. Sole Licencees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 8746
The Scottish Tube Co., Ltd., Head Office: 34, Robertson Street, Glasgow.
See Advertisement page 75, Nov. 25.

Yarrow & Co., Ltd., SHIPBUILDERS AND ENGINEERS, GLASGOW.
SPEEDS UP TO 45 MILES AN HOUR.
PADDLE OR SCREW STEAMERS OF EXCEPTIONAL SHALLOW DRAUGHT.
Repairs on Pacific Coast by YARROWS, LIMITED, Victoria, British Columbia. 9563
Shipbuilders, Ship Repairers and Engineers.

Campbells & Hunter, Ltd. Gear Cutting.
Worm Wheels cut up to 13 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
Spur Wheels cut up to 9 ft. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

Yachts, Launches or Barges Built complete with Steam, Oil or Petrol Motors; or Machinery supplied. Od 3551
VOSPER & CO., LTD., Broad Street, Portsmouth.

Cement.—Maxted & Knott, LTD., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1890.
Address, Burnett Avenue, Hull.
Cablegrams: "Energy, Hull," 9769

Oil Fuel Appliances, *Systems* Pressure, Air, Steam *For Boilers of all types.*
KERMODES LIMITED, 35, The Temple, Dale Street, Liverpool; and Messrs. Bucknall & Riches, 8, Southampton Row, London, W.C.1.
Telephone No.: Museum 6684.
Naval Outfits a Speciality. 4078

Locomotives Tank Engines designed and constructed by MANNING, WARDLE AND COMPANY, LIMITED, Boyne Engine Works, Leeds. Od 2487
See their Illus. Advertisement, page 103, last week.
RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd. The Glasgow Rolling Stock and Plant Works, Motherwell. Od 3382

R. Y. Pickering & Co., Ltd., (ESTABLISHED 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS.
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices: WISHAW, near GLASGOW.
London Office: Od 8353
2, Victoria Street, Westminster, S.W.

Henry Butcher & Co., AUCTIONEERS, VALUERS AND SURVEYORS for ENGINEERING AND ALLIED TRADES and INDUSTRIAL PROPERTIES. 8134
63 and 64, CHANCERY LANE, LONDON, W.C.2.

Electric Lifts (UP TO 35 TONS.) 9030
S. H. HEYWOOD & CO., LTD. REDDISH.

John H. Wilson & Co., Ltd., Birkenhead.
See Illustrated Advertisement Page 100, Jan. 28.

Locomotive Shunting Cranes

Steam and Electric Cranes EXCAVATORS, CRANE-NAVVIES, GRABS, CONCRETE-MIXERS, SHIPS' WINDLASSES, WINCHES, and DECK MACHINERY. 9364
Lists of Standard Sizes on Application.
London Office: 15, VICTORIA STREET, S.W.1.

John Bellamy, Limited, MILLWALL, LONDON, E. 1216
General Constructional Engineers,
Boilers, Tanks, & Mooring Buoys
Stills, Petrol Tanks, Air Receivers, Steel Chimneys, Riveted Steam and Ventilating Pipes, Hoppers, Special Work, Repairs of all kinds.

Tubes and Fittings.

Stewarts and Lloyds, Ltd., Glasgow and Birmingham.
See Advertisement page 61. 9091

Machine and Engineering WORK of all descriptions undertaken for Manufacturers, Patentees, &c. Also repairs and renewals. Best work, moderate charges.—ROSSER & RUSSELL, LTD., Queen's Wharf, Hammersmith.
NEW PATENT ACT.—Rosser & Russell, Ltd., are prepared to undertake the manufacture of articles at present made abroad, and will be pleased to hear from firms desiring such work executed. 9211

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. LTD., London Office—12, Victoria Street, S.W.
MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 9241
The Glasgow Rolling Stock and Plant Works.
Hurst, Nelson & Co., Ltd., Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of Wheels and Axles, Railway Plant, Forgings, Smith Work, Iron & Brass Castings.
Pressed Steel Work of all Kinds.
Registered Office and Chief Works: Motherwell.
London Office: 14, Leadenhall Street, E.C. Od3382

Patents DESIGNS AND TRADE MARKS IN ALL COUNTRIES.
E. P. Alexander & Son, CHARTERED PATENT AGENTS, 306, HIGH HOLBORN, LONDON, W.C. (Established 1874.)
Telephone: Central 7494. Od 586

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, Leadenhall St., E.C.3.
Works: Burnt Mill, near Harlow, Essex.
Makers of Evaporating and Distilling Plants. Refrigerating and Ice Making Machinery. Feed Water Heaters. Evaporators. Fresh Water Distillers. Main Feed Pumps. Combined Circulating and Air Pumps. Auxiliary Surface Condensers. &c. &c. 9604

Electric Cranes.
S. H. HEYWOOD & CO., LTD., REDDISH. 9026

The National Foremen's ASSOCIATION OF THE ENGINEERING AND ALLIED TRADES. (Registered under the Trade Union Act.)
An Association specially formed to look after the interests of Foremen on their Supervisory Capacity. P 601
All communications to— H. W. REID, General Secretary. Head Offices— 96, Belgrave Road, Victoria, London, S.W.1.

CHANTIERS & ATELIERS.
Augustin-Normand 61, rue de Perrey—LE HAVRE (France). 2220
Destroyers, Torpedo Boats, Yachts and Fast Boats, Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

Royles Limited, ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS. AIR HEATERS, STEAM AND GAS KETTLES, Merrill's Patent TWIN STRAINERS for Pump Suctions. } Row's Patents.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5733

Yarrow Patent Water-tube Boilers. 9664
Messrs. YARROW & CO., UNDERTAKE the PRESSING and MACHINING of the various parts of Yarrow Boilers, such as the Steam Drums, Water Pockets, and Superheaters for British and Foreign Firms not having the necessary facilities.
YARROW & CO., LTD., Scotstoun, Glasgow.

Matthew Paul & Co., Ltd. Levenford Works, Dumbarton. 9518
See Full Page Advt., page 72, Nov. 11.

Forgings.
Walter Somers, Limited, HALESOWEN. 7116

Head, Wrightson & Co., LIMITED.
See Advertisement page 65. 3403

Taylor & Challen Presses 8195
About 200 NEW PRESSES in Stock in our Showrooms for immediate delivery at specially Reduced Prices.
TAYLOR & CHALLEN, LTD., Engineers, Constitution Hill, Birmingham.
See Full page Advertisement page 58, Nov. 11.

FOR **Drop Forgings** write GARTSHERRIE ENGINEERING & FORGE CO., 60, Wellington Street, Glasgow. 9074

"Spencer-Hopwood" Patent WATER TUBE **Boilers.** *See page 10* 9293
Sole Makers: SPENCER-BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

GRAPHITED OIL. **"OILDAG"** (Reg.) BRAND.
GRAPHITED WATER. **"AQUADAG"** (Reg.) BRAND.
GRAPHITED GREASE. **"GREDAG"** 9505

E. G. Acheson Ltd., Dept. E., (Sole Manufacturers.) 40, Wood St., S.W.1. Works: Plymouth.

Locomotive Traversers (ELECTRIC). 9030
S. H. HEYWOOD & CO., LTD., REDDISH.

P. & W. MacLellan, Limited, CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION, RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices; 129, Trongate, Glasgow. Od 3547
Registered Offices; Clutha House, 10, Princes St., Westminster, London, S.W.1.

Centrifugals.
Pott, Cassels & Williamson, MOTHERWELL, SCOTLAND. 9737
See half-page Advertisement page 76, Nov. 25.

The Manchester Steam Users' Association.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER. Chief Engineer: G. E. STROMEYER, M.I.C.E. Founded 1854 by SIR WILLIAM FAIRBAIRN. Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 9310

Correspondence Courses for B.Sc., Inst. C.E., I. Mech. E., all ENGINEERING EXAMS. Special Courses and Single Subjects. Personal tuition.—For full particulars apply to MR. TREVOR W. PHILLIPS, B.Sc. (Hons.). Assoc.M.Inst.C.E., M.R.S.I., etc., 8-10, Trafford Chambers, 58, South John Street, Liverpool. 9296

Inst. C.E., I. Mech. E., B.Sc., and all Engineering Examinations.—Mr. G. P. KNOWLES, B.Sc., M.E.E., A.M.Inst.C.E., F.S.I., M.R.San.I., PREPARES CANDIDATES personally or by correspondence. Thousands of successes during the last sixteen years. Courses may commence at any time.—39, Victoria St., Westminster, S.W. Tel. 4780 Victoria. 9814

Inst. C.E. Exams.—Successes as usual last Exam. by Correspondence Coaching. Successes by hundreds, several prizes. Sec. "O" embraces 25 years' professional experience. Address, 7434, Offices of ENGINEERING.

TENDERS.

For Sale, By Tender.— GENERAL ENGINEERING PLANT and Workshop Equipment, Lathes, Drillers, Milling Machines, Shafting, Pulleys, etc. Quantity of electrical material. Patent Washing Machines and General Effects.-Particulars and forms of Tender may be obtained of H. A. ALLISON, Chartered Accountant, Kennan's House, Crown Court, Cheapside, E.C.2. S 776

LONDON COUNTY COUNCIL.

Tenders are Invited for the REMOVAL and DISPOSAL of ASHES from the Power Station at East Greenwich, for alternative periods of six and twelve calendar months, commencing on 1st February, 1922.

Particulars and Forms of Tender may be obtained from the General Manager, London County Council Tramways, 23, Belvedere Road, Lambeth, S.E. 1.

No Tender will be considered if received at County Hall, Spring Gardens, S.W. 1, after Twelve noon on Tuesday, 13th December, 1921.

The Council does not bind itself to accept any Tender.

JAMES BIRD,
Clerk of the London County Council. S 788

TO ENGINEERS AND BUILDING CONTRACTORS.

The Metropolitan Asylums Board invite

Separate Tenders for the following WORKS at Princess Mary's Hospital, Margate, Kent.

(1) Transfer and re-erection of Steam Boilers, and the installation of Boiler Feed Pumps, Water Softening Plant, Calorifiers and the Revision of Heating and Hot Water Supplies.

(2) Erection of New Boiler House, Coal Store, &c., and other incidental works in connection therewith, each in accordance with drawings and specifications prepared by Mr. T. COOPER, M.Inst.C.E., M.I.Mech.E., Engineer-in-Chief. The drawings, specifications, and forms of Tender may be inspected at the Office of the Board, Embankment, E.C. 4, on and after Ten a.m. on Thursday, 1st December, 1921, and the drawings, specifications and forms of Tender can then be obtained upon payment of a deposit of £1 in respect of each work. The amount of the deposit will be returned only after the receipt of a *bona-fide* Tender sent in accordance with the instructions on the form of Tender and after the specification and the drawings have been returned.

Tenders addressed as noted on the forms of Tender must be delivered at the Office of the Board not later than 2.30 p.m. on the 21st December, 1921.

By Order,
DUNCOMBE MANN, S 743
Clerk to the Board.

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY AND FIXING OF LANCASHIRE BOILERS, SUPERHEATER, PIPING AND FEED PUMPS AT DEPTFORD, S.E. 8.

The Metropolitan Water Board invite

Tenders for the Supply and fixing of Two Lancashire Boilers, Superheater, Piping, Feed Pumps, etc., at their Deptford Pumping Station, Brookmill Road, S.E. 8.

Forms of Tender, Conditions of Contract, Specification and Drawing may be inspected without payment of fee at the Offices of the Board (Room 194), Chief Engineer's Department, 173, Rosebery Avenue, Clerkenwell, E.C. 1, on and after Tuesday, December 6th, 1921.

Contractors desirous of tendering may obtain the necessary documents from Mr. HENRY E. STILGOE, M.Inst.C.E., the Chief Engineer, on production of an official receipt for the sum of £1 1s., which sum must be deposited with the Board's Accountant and will be returned on receipt of a *bona fide* Tender together with all incidental papers.

Such payments and applications must be made between the hours of Ten a.m. and Four p.m. Thursdays excepted (Saturdays Ten a.m. to Twelve noon).

Tenders, enclosed in sealed envelopes addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery Avenue, E.C. 1," and endorsed "Tender for Boilers, Deptford," must be delivered at the Offices of the Board not later than Ten a.m. on Wednesday, 18th January, 1922.

W. MOON,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue, E.C. 1.
November, 1921. S 661

BOMBAY, BARODA AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Thursday, 22nd December:—

Tenders for the Supply of:—

1. ROLLED MATERIAL for the construction of Bogie Wagons.
2. PARTS for constructing Bogie Wagons.
3. AXLEBOXES for Wagons.
4. WHEELS and AXLES.
5. LAMINATED BEARING SPRINGS.
6. STEEL BOILER TUBES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France,
Westminster, S.W. 1.
29th November, 1921, S 789

LONDON COUNTY COUNCIL.

TRAMWAY SUPPLIES, ELECTRICAL EQUIPMENT, ETC.

Applications are Invited from Firms, and particularly Manufacturers, for permission to be placed on the lists of persons and firms from whom the Council from time to time invites TENDERS for the SUPPLY of the UNDERMENTIONED FITTINGS, ELECTRICAL and MECHANICAL EQUIPMENT and SPARES, etc., required for the Council's Tramways:—

Class No.
1. Car Motors, complete and spares.
2. Coils Armature, Field and Magnetic Brake.
3. Gear and Pinion Wheels.
4. Armature Rewinding and Repair.
5. Machined Bronze Bearings.
6. Machine finished Articles (Brass, Gunmetal, etc.).
7. Do. Do. (Iron, Steel, etc.).
8. Iron and Steel Drop Forged Stampings.
9. Iron and Steel Forgings.
10. Springs for Electric Car Trucks.
11. Iron Castings, machined and not machined.
12. Brake Shoes for Electric Car Trucks.
13. Malleable Iron Castings, machined and not machined.
14. Steel Castings, machined and not machined.
15. Truck Sides.
16. Castings, Brass, Gunmetal, Phosphor Bronze, Aluminium.
17. Whitemetal and Bearing Alloys.
18. Rolled Steel Bars for Magnetic Brake Shoes.
19. Channels, Angles and Special Sections.
20. Tyres, Steel for Tramcars,
21. Car Controllers complete and Spares.
22. Controller Fingers, Segments, etc.
23. Canopy Switches, Circuit Breakers and Spares.
24. Rheostats, complete and Spares.
25. Pressed Brass and Steel Articles.
26. Carbon Brushes for Tramcar Motors and Generators, etc.
27. Wire, Copper, Cotton covered.
28. Cable, Electric.
29. Car Furniture and Fittings.
30. Moulded Rubber Articles.
31. Moulded Insulators (other than Rubber).
32. Fibre Articles.
33. Mica and Micanite Articles.
34. Press-spahn.
35. Insulating Varnishes.
36. Foundry Crucibles and Requisites.
37. Transfers Coachpainters,
38. Tyres, Rubber for Motor Vehicles,
39. Electrical Line Equipment (Overhead).
40. Do. Do. (Conduit).
41. Copper Bonds.
42. Acetylene Generators and Lamps.
43. Welding Work.
44. Welding Plant and Electrodes.
45. Stone Crusher Rolls, Jaws, etc.
46. Granite Sets.

Applications must be made on the official form, copies of which, together with a statement giving further information on the subject, including the standard conditions of contract, may be obtained from the General Manager, Tramways Department, 23, Belvedere Road, S.E. 1.

In those cases in which Tenders are limited to manufacturers or producers, applications from agents, middlemen, or dealers, will not be considered.

Firms making application for inclusion in the selected lists of Tenderers, will be informed in due course of the Council's decision in the matter.

Attention is drawn to the fact that, in cases in which the name of a person or firm has been placed on the Council's lists, it is not necessary for such person or firm to apply for form of Tender, as in all suitable cases forms of Tender will be sent from time to time as issued.

Applications for inclusion in the first lists of selected firms for the supply of the goods and articles enumerated above must be sent in not later than 31st December, 1921. Applications received thereafter will receive consideration in connection with future supplies.

JAMES BIRD,
Clerk of the London County Council.
S 760

APPOINTMENTS OPEN.

The Stanton Ironworks COMPANY, LIMITED, near Nottingham, REQUIRE the SERVICES of a WORKS MANAGER for their Reinforced Concrete Pipe Works. Qualifications primarily ability to handle men, with some knowledge of Concrete.—Reply, in writing, to above. S 669

Works Manager Required for general engineering work, London area, employing approximately 100 men. Must have knowledge of economical production with up-to-date methods, also knowledge of costing. Salary to commence £550 per annum. State experience concisely and briefly, age and when free, to—BOX 419, MAXWELL Agency, 9, Curaitor Street, London, E.C. 4. S 790

A Temporary Research ASSISTANT is REQUIRED by the Radio Research Board to undertake research work under the Board in WIRELESS TELEGRAPHY. Salary will be at the rate of from £300 to £350 per annum inclusive, according to qualifications. The candidate should possess good academic qualifications, and should preferably have had at least one year's experience in electrical research or test work.—Applications, accompanied by testimonials, should be addressed in writing to the SECRETARY, RADIO RESEARCH BOARD, Department of Scientific and Industrial Research, 16 and 18, Old Queen Street, London, S.W. 1. S 752

Wanted, Experienced Ma- chinery SALESMAN for India, by Calcutta Firm of Engineers. Public school boy preferred. Five year agreement, pay commencing Rs. 600 a month. No married men will be considered.—Write, Z. J. 286, care of DEACON'S, Leadenhall St., London, E.C. 3, stating age, experience and salary required. S 795

Civil Engineer, fully qualified, REQUIRED, inspecting, reporting, improving heavy construction work progress various parts of the world. Good languages essential. Splendid opening for gentleman possessing tact, discretion and experience big lay-out. Highest references required. — Communicate in first instance, together with copies record which will be treated in strict confidence, by letter, to SOLICITORS, care of J. W. VICKERS & Co., LTD., 9, Nicholas Lane, E.C. 4. S 757

COUNTY BOROUGH OF CROYDON.

WATER DEPARTMENT.

APPOINTMENT OF ASSISTANT MECHANICAL ENGINEER FOREMAN.

Applications are Invited for the POSITION of ASSISTANT MECHANICAL ENGINEER FOREMAN. The person appointed must be a well qualified engineer with a thorough knowledge of Pumping Engines and Plant generally. The engines are of various types, principally steam. The duties include assisting in the management of pumping stations, fitters' shop and repairs. Salary £340 per annum, rising by annual increments of £15 to £390, with house, coal and light free.

Applications in candidates' own handwriting, with copies (not originals) of not more than three testimonials of recent date, to be sent to the Borough Engineer, Town Hall, Croydon, not later than Eleven o'clock in the forenoon of Tuesday, the 6th day of December, 1921.

JOHN M. NEWNHAM,
Town Clerk.
Town Hall, Croydon.
21st November, 1921. S 748

MANCHESTER CORPORATION WATERWORKS.

The Waterworks Committee invite

Applications from Fully Qualified Engineers for the following appointments:—

RESIDENT ENGINEER during the construction of a Service Reservoir, who must have sound organising ability, experience in the control of men and in the construction of large reservoirs. Salary £700 per annum (inclusive).

ASSISTANT WATERWORKS ENGINEER, who must have similar qualifications, and, in addition, experience in the administration of a large Waterworks Undertaking. Commencing salary £800 per annum (inclusive).

Applicants for either appointment must be Members or Associate Members of the Institution of Civil Engineers.

Applications, on forms to be obtained from the SECRETARY, Waterworks Offices, Town Hall, Manchester, must be sent in not later than the 19th December, 1921. S 782

SHANGHAI MUNICIPAL COUNCIL.

ELECTRICITY DEPARTMENT.

CONSTRUCTIONAL ENGINEER AND ASSISTANT CONSTRUCTIONAL ENGINEER.

The Electricity Department of the Shanghai Municipal Council requires the

Services of a Constructional ENGINEER and an ASSISTANT CONSTRUCTIONAL ENGINEER to take charge of the design and construction of new buildings and maintenance of existing buildings for the Department. The work comprises both reinforced concrete construction and steel-work construction, together with piling and rafts, for foundations of large Power House buildings, Sub-stations and machinery.

CONSTRUCTIONAL ENGINEER.—The duties of the Constructional Engineer will be to design all classes of engineering buildings and draw up complete specifications, and supervise the execution of the works by Chinese Contractors or by direct Chinese labour. The Engineer appointed will be head of a sub-department and must be capable of organising and controlling a large staff.

ASSISTANT CONSTRUCTIONAL ENGINEER. — The duties of the Assistant Constructional Engineer will be to assist the Constructional Engineer in all his work and during his absence, if necessary, to act as his deputy.

Candidates for the two appointments must have had thorough technical education and practical experience in large constructional works. They should have passed the examination for Associate Membership of the Institution of Civil Engineers or equivalent examination, and preferably have had experience abroad upon large public works contracts. Evidence as to technical knowledge and organising ability essential.

The salary of the Constructional Engineer will be 600 taels per month and of the Assistant Constructional Engineer 400 taels per month. The present rate of exchange is about 4s. per tael. The first engagement will be three years and free first-class passage out and home again. Free medical attendance and superannuation are given.

Applications, in writing only, stating age, with full particulars of training and experience, together with copies of recent testimonials and names of references as to personal character to be sent to Messrs. PREECE, CARDEW & RIDER, 8, Queen Anne's Gate, Westminster, S.W. 1, not later than Friday, December 16th. S 778

Gentleman Required by Im- portant Industrial Company engaged in the production of non-ferrous metals to organise and take charge of a department for Propaganda for extending the uses of well-known metal in the Engineering and Allied Trades. Sound engineering and technical training essential. Preference will be given to one with knowledge of German and French. Liberal salary offered to one possessing the necessary experience and qualifications.—Applications to be made in writing in the first instance to R. T., 64, Cannon Street, London, E.C. 4. S 773

Assistant Wanted for Civil Engineer's Office. Must be experienced in quantities, and have highest references.—Address, stating experience, age, salary, &c., S 793, Offices of ENGINEERING.

Wanted for Overseas, Thoroughly Competent ASSISTANT CIVIL ENGINEER, with considerable experience in reinforced concrete design, particularly in piers and jetties. Knowledge Portuguese or Spanish desirable. — Address, giving full particulars of experience, &c., S 751, Offices of ENGINEERING.

Engineer Required by Société HOPKINSON (Valves and Boiler Mountings) 94, Rue St. Lazare, PARIS, as Assistant to Manager. Applicants must be British, age 28 to 35, with technical and commercial experience, general knowledge steam power plants, and good French. — Applications by letter, giving all particulars and salary required. S 754

Required by Old-established Engineering Company in India, thoroughly trained and educated Technical ENGINEER, age 22-26, single, with University Degree, B.Sc. preferred. Office experience in addition would be a recommendation.—Reply fully, stating age, salary expected and experience, to Z.A. 947, c/o Messrs. DEACONS', Leadenhall Street, London, E.C. 3. S 683

Wanted for Overseas, Highly Competent CIVIL ENGINEER or Chief Agent of wide experience, capable of taking complete charge of large contract, including superintending and controlling engineering and constructional staffs on concrete masonry dams and other works. Knowledge Portuguese or Spanish essential.—Address, giving full particulars of experience, &c., S 740, Offices of ENGINEERING.

S 283. Works Superintendent. The Advertiser wishes to inform applicants for the above POST that the vacancy has been FILLED. S 792

Wanted, by a Firm of Old- established Steel Founders, YOUNG GENTLEMAN (with a Public School Education) with Engineering knowledge, experience and influence, to act as full time Representative for the sale of Steel Castings on commission basis in Manchester and Birmingham districts.—Address, S 745, Offices of ENGINEERING.

Two Experienced Cost Clerks REQUIRED accustomed to costing electrical instruments. Applicants must give full particulars of previous experience and state age, and salary required.—MARCONI'S WIRELESS TELEGRAPH CO., LTD., Chelmsford. S 775

Junior Draughtsman for Electrical Instrument Works near London. —Address, stating age, experience and salary required, S 746, Offices of ENGINEERING.

Wanted, Good General DRAUGHTSMAN, N.W. London District, practical experience necessary. State, salary required with age and experience.—Address, S 717, Offices of ENGINEERING.

James Carmichael & Co., Ltd., Ward Foundry, Dundee, REQUIRE LEADING DRAUGHTSMAN in connection with Uniflow Engine design. Applicants to state experience, age and salary. S 771

SINGAPORE, STRAITS SETTLEMENTS.

WATER DEPARTMENT.

The Municipal Commissioners of Singapore require

Two Assistant Engineer DRAUGHTSMEN, unmarried, age 25-35, on a three years' Agreement, with possible extension. They must have a good education, a good training in a Civil Engineer's office, and must have a practical knowledge of Surveying, Levelling and Draughtsmanship, preferably with experience in the design and construction of new waterworks and appurtenant works and buildings. They would be employed chiefly on the design of waterworks, and would work under the instructions of assistant engineers. Salary, 5,400 dollars for the first, 5,880 dollars for the second and 6,360 for the third year, paid monthly in dollars, the currency of the Colony, the value of the dollar being fixed at 2s. 4d. sterling. The pay of the appointment for the first year at this rate would be £630. In addition, there is, at present, a temporary allowance of fifteen per cent. on the salary, which is subject to revision at any time. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passages will be provided, with half pay during the passage out. Each of the selected Candidates must pass a Medical Examination. Applications, stating whether married or single, age and place of birth, and giving details of education, training and experience generally, and in Waterworks particularly, and referring to all the above requirements in detail, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. C. LINDSAY & PRINCE, M.M.Inst.C.E., 180, Hope Street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 13th December, 1921. S 666

CANADIAN AUTOMATIC CONVERTER SUB-STATION.

THE automatic synchronous converter sub-station in which all operations are performed without manual supervision, has passed through its development stage and is now a recognised means of feeding traction systems. Two general schemes of control have been brought out, one, in which a master drum-controller initiates the various operations in sequence, and the other, in which these steps take place through the guidance and control of various relays which function according to a predetermined plan, as each previous step has been completed. The Ossington-avenue station of the Toronto hydro-electric system, just recently completed, is of the latter or Westinghouse type, and aside from certain features of design it is of interest in being the first Canadian automatic converter station to be placed in successful operation.

The substation as at present laid out is of 1,000 kw. capacity, with provision for extension, and provides an additional means of supplying energy to the St. Clair-avenue Civic car line. Formerly this line was fed entirely by means of two 500-kw. rotaries in the system's high level sub-station, about 2 miles distant from the corner of Ossington and Benson-avenues, where the new station is located, one block south of St. Clair-avenue.

At the time when preliminary plans and estimates were developed by the engineering department of the Toronto hydro-electric system, building costs were at an extremely high level, and this was a decided factor in the arrangement of equipment, the aim being to provide for a lay-out as economical of space as possible while retaining a well-balanced design. As finally approved and constructed, the station (Figs. 1 to 3) is 25 ft. square with an 11-ft. basement. Deducting a portion of the basement left unexcavated, the volume is about 18,000 cub. ft. approximately, or 18 cub. ft. per kilowatt of installed capacity. The walls are of buff pressed brick inside and out, while the main floor and roof are of reinforced concrete slab construction on fireproofed steel beams. A 10-ton Northern hand-operated crane is installed, two columns supporting the crane girders at the rear of the station for future extension, when required. Construction and maintenance rooms for the storing of supplies for these two departments are provided in the basement, while lavatory accommodation is available in a small enclosed space on the main floor. A receiving entrance is provided on grade level, in front, into which trucks may be driven and unloaded directly by crane. This entrance also serves as the main entrance to the station, access being had to the main floor by a short flight of steps and to the basement by the same means, also from grade level. The roof is reached through a trap and by means of a ladder, which also serves a landing at crane height for crane inspection and painting.

General Operating Features.—In general, operation closely follows hand practice, the station starting up when required, through low trolley voltage. It can also be remote controlled through the use of the oil circuit breaker in the station at the other end of the high-tension feeder supplying energy. In starting up, the transformer oil circuit breaker closes, energising the transformers after the starting contactors are closed, and the machine then builds up in speed, during which time polarity is checked, and if found incorrect is reversed automatically. As the machine comes into synchronism, the starting contactor opens and the running contactors close, brushes are lowered and the machine placed across the line. Protective relays guard against every possible trouble due to operating or mechanical difficulties, and the installation in this respect is more completely protected than any manually-operated converter.

Equipment in Detail.—Energy is received from the high-level sub-station through a 13,200-volt, 25-cycle, three-phase overhead transmission line directly off the main station busses through a 300-ampere oil circuit breaker. An auxiliary source of supply is also available through a tap off the system's ring main, and it is thus possible to feed directly from either the high-level station through two lines or from the West Toronto station through one.

The transmission lines are dead-ended back of the station roof, entrances are employed and the incoming lines are both provided with disconnecting switches, below which the two are united and the lightning arrester (Westinghouse type AK) connected in. Two hundred watt oil-immersed potential transformers are provided, while two sets of 60/5 ampere current transformers are installed, one set for metering the station load and the other for the automatic control equipment.

Fig. 1.

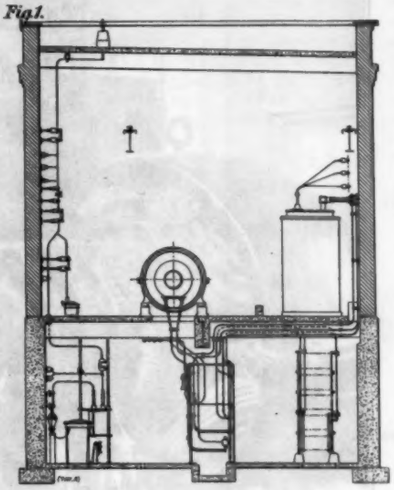


Fig. 2.

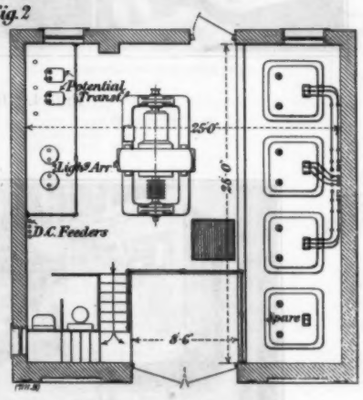
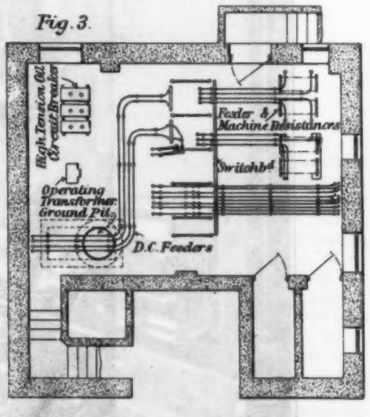


Fig. 3.



The main converter transformers are energised through a type E-9 remote-controlled solenoid-operated oil circuit breaker, which functions as part of the automatic control equipment. An operating transformer, 13,200/440/110 volts, is connected in on the line side of this breaker and serves to furnish energy at both 440 volts and 110 volts to the various control circuits. It is of 15 k.v.a. capacity and is protected by expulsion fuses.

The rotary transformers (see Fig. 4, page 748) are rated at 400 k.v.a. each, and are of the oil-insulated self-cooling type, single phase. The primary voltage is 13,200, and the secondary 425 for diametral connection. Four are provided, one acting as spare in the event of trouble on the operating bank.

The rotary converter is of the standard Westinghouse, 1,000-kw. type, 600-volt direct-current, and is provided with compound field windings and commutating poles. The usual speed limit device and brush-operating mechanism are also provided together with bearing thermostats, which serve to shut down the station consequent upon overspeed or bearing trouble. The commutating fields necessitate brush lifting during starting to avoid excessive sparking at the direct-current brushes, and this operation is performed automatically by a brush-lifting motor fitted with reduction gearing and interlocks, and housed in a cast-iron box attached to the rotary bedplate. The converter is set directly on the main floor of the station which has been designed of sufficient strength to carry it without foundations. All leads are brought up from below through large floor openings inside the frame.

Switchboard.—The switchboard, Fig. 5, is installed in the basement, and consists of a metering panel for metering the station load; a starting panel upon which the starting and running contactors are placed; a relay panel upon which most of the relays are mounted; a machine panel upon which the machine and its resistance contactors are mounted, and a feeder panel controlling through contactors, the feeders and their resistances. The relay and metering panels are isolated from the contactor panels by being separated from them by about $\frac{1}{2}$ in. and by being mounted on separate pipe supports. This arrangement frees them from shocks and jarring due to the heavy contactors closing. The panels rest on a 6-in. channel let into the floor, and having a pit 12 in. deep and 2 ft. wide at the rear. All controls are brought into this pit and interconnections there made.

The shunt field rheostat together with other auxiliary equipment is mounted behind the board on its supporting framework.

Station Wiring.—The station wiring has been done in conformity with Toronto hydro-electric system practice. For the high-tension leads and connections to the station disconnecting switches, $1 \times \frac{1}{8}$-in. wall copper tubing has been used, left bare and given a brush finish. Connection from the circuit breaker to the transformer delta is made by No. 2, paper insulated, lead covered, three-conductor cable in $3\frac{1}{2}$-in. conduit. The high-tension delta is constructed of $1 \times \frac{1}{8}$-in. wall copper tubing supported on General Devices and Fittings Company bus-bar supports, and insulated by means of red fibre tubing slipped on. The low-tension leads have been brought out of the transformers in flat copper and for each of the running taps two 750 m.c.m., V.C.I. cables are carried away in parallel, while for the starting tap only one cable of the same size is used.

The low-tension cables are racked on the wall, carried down through the floor and along the ceiling of the basement to the starting contactor panel, where one set of leads is brought up directly to the converter rings while the starting leads are dropped down into the starting contactor and the remaining leg connected to the running contactors, two being used in parallel, for the securing of the proper current-carrying capacity.

The direct current leads from the commutator of the machine are brought down to the machine panel directly below, while the feeders, which have been carried out overhead, are each of 1,000 m.c.m. size, two negatives and two positives being provided. It may be mentioned that the negative feeders are completely insulated from ground in the station and on the line to where they attach to the track network. This has been done for the minimising of electrolysis.

Resistance grids have been installed on both the machine and feeder circuits. These come into operation upon heavy overloads, and serve to limit the current to the 2-hour rating of the machine. Provision has been made for the cutting out of the

station when these resistances reach the maximum safe operating temperature, the station coming in on the line again when their temperature has again dropped to a safe valve. These grid resisters are installed in the basement, and connection to them is made by means of 1,000 m.c.m. cable, one or two in parallel being used as required for the proper current-carrying capacity. All low-tension and direct-current cabling is exposed, no conduit work being used, and the whole racked in clamp insulators of General Devices and Fittings make, supported on pipe brackets.

Operation in Detail.—A simplified connection diagram is shown on the accompanying sequence chart, Figs. 6 to 8, and by its aid the general principles of operation may be readily understood.

Assuming the trolley voltage to fall to the valve at which the station has been set to operate, relay (1) which is a low-voltage relay set to operate at a predetermined figure and which is connected across the trolley bus to negative potential, operates and closes a set of contacts which are in series with relay (2). If the oil circuit breaker is in its open position and the brushes are up, this completes a circuit through interlocks on the breaker and brush-lifting mechanism, from (B) bus to the 110-volt tap on the operating transformer, thus permitting relay (2) to function. Relay (2) is a type CV. low voltage and time delay relay operating on the induction principle. It not only guards against low alternating current voltage, but it also interposes a time interval of about 5 seconds during which, if the trolley potential is restored, relay (1) opens and the station does not start. This feature prevents the station from starting due to momentary variations of the trolley voltage. Relay (2) is calibrated to close its contacts on 80 per cent. of normal operating potential, thus enduring satisfactory operating conditions.

The double-pole, double-throw knife switch 17 provides for either full automatic or continuous operation. In the up position relay (1) is operable as is also relay (27). In the down position, for continuous operation, the rotary will start up as soon as the switch is closed in, relay (1) being cut out and (27) also rendered inoperable. Relay (27), which will be described later is for the shutting down of the station under light load.

Relay (2) is provided with two sets of contacts, one closed when it is de-energised, and the other closed when the time delay period has passed, the first set is shunted across the closing coil of contactor (21), while the second set is in series with its closing coil. On the energising of the coil of (2) the contacts shunted across the contactor (21) are opened and a few seconds later those in series with its coil are closed, energising it from A and B busses through resistance.

Shunt contactor (21) makes its own holding circuit through a set of contacts, even though the contacts (2) in series with its coil are opened. In closing, shunt contactor (21) energises contactor (3). Contactor (3) is a master relay, since through it all subsequent operations are performed. As soon as this relay closes, it makes its own holding circuit through a set of contacts in parallel with those of relay (21), which renders it independent and permits it to remain in until it is shunted by contacts in parallel with its own closing coil. In closing, shunt contactor (3) energises an auxiliary operating bus (A–1), through which all following operations are controlled. A number of circuits are immediately energised; potential is now placed across the coil of shunt relay (4) through interlocks on the running contactor, closed when it is open; this relay in closing performs a number of functions. It energises the starting contactor (6), closing it in, and at the same time closes in another relay (22) which energised the coil of the oil circuit breaker. The oil circuit breaker thus closes after the starting contactor has closed; and in closing, it opens contacts (20) in series with relay (2), thus de-energising it, and in consequence opening contacts (2) in series with the coil of (21). This step has no effect until relay (2) in coasting back against its damping magnets comes to rest in the full open position, closing its contacts in parallel with (21), and shunting it. Relay (21) is then de-energised, (22) also falls out, and the closing coil of the circuit

CANADIAN AUTOMATIC CONVERTER SUB-STATION

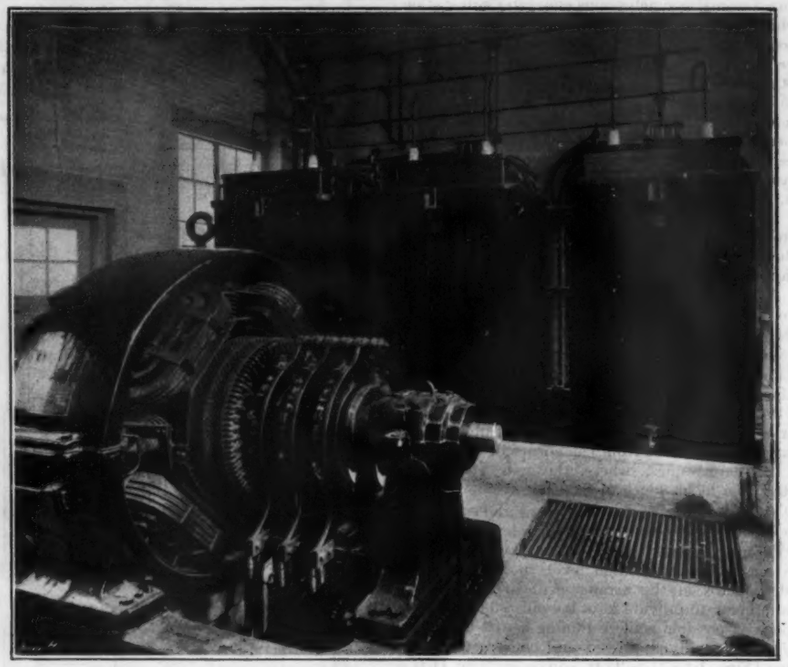


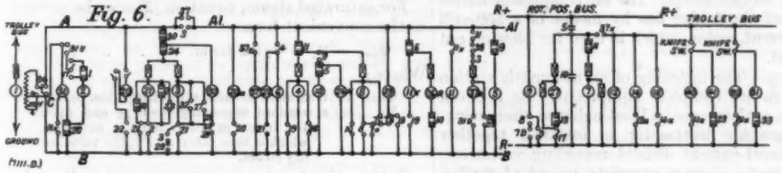
Fig. 4. Rotary Converter.

Fig. 5. Switchboard.

breaker is thus de-energised. The holding circuit of (21) on itself thus introduces a time element, during which the circuit breaker has time to latch itself in through the energising of the low-voltage release coil (20A) from bus (A–1), this coil is interlocked with contacts (20) on the switch so that it will not function until the oil switch is completely closed. When the station shuts down (20A) is de-energised, releasing the latch and opening the oil switch.

It should be noted that both relays (21) and (3) are in series with contacts (24) and (30) and will not operate unless these latter are closed. Should they be open, neither the oil switch, closing coil, nor the auxiliary control bus will be energised, and the station remains dead. No. 24 is the over-speed device and (30) is a lock-out relay, both of which have to be manually re-set after functioning.

Fig. 6.



○ - Contacts open when Relay is de-energized.

⊟ - Contacts closed when Relay is de-energized.

◯ - Closing coil of Contactors & Relays

⊠ - Resistance Tubes. (THM.6)

LIST OF APPARATUS.

1. D.C. low voltage relay.
2. A.C. low voltage and time relay (C.V.).
3. A.C. shunt relay (main control relay).
4. A.C. shunt relay.
5. Field contactor (correct polarity).
6. A.C. starting contactor.
7. Polarised motor relay.
8. A.C. shunt relay.
9. Field reversing relay
10. Field contactor (reverse polarity).
11. A.C. running contactor.

11X A.C. shunt.

12. 14–16 D.C. converter contactors.

12A–14A. D.C. accelerating relays.

13. D.C. series underload relay.
17. 2 P.D.T. knife Sw., up for auto, down for non-auto.
18. Reverse Ph. and low voltage relay (C.P.).
19. A.C. shunt relay.
20. Oil Cir. Bkr.

20A. Trip coil of oil Cir. Bkr.

21. A.C. shunt relay.
22. A.C. 125 Amp. contactor.
23. A.C. overload relay (C.O.).
24. Overspeed device.
25. Bearing thermostats.
26. Field reversing limiting relay (notching).
27. Underload delay relay.
28. Grid thermostats.
29. Replica thermal or temperature protective relay.
30. K.N. relay.
31. Brush lifting mechanism.
32. D.C. reverse current relay.
34. D.D. fused Sw. on A and B potential.
35. Feeder grid thermostats.
37. D.C. live contactor (A.C. operated).

37X. A.C. shunt relay.

38. Field current relay.

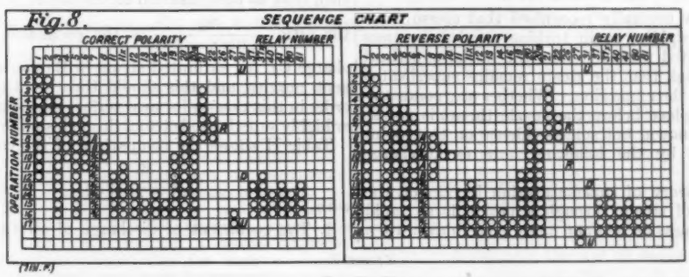
40–80. D.C. resistance shunting relay.

41–81. D.C. live contactors.

41A–80A. Accelerating relays.

39–6. Ph. protection relay.(C.O.).

Fig. 8. SEQUENCE CHART



The lock-out relay can be energised from three sources—from the type CO relays on the alternating-current side; from the bearing thermostats, and from a protective relay of which the thermal characteristics are those of the machine itself, and which operates on excessive temperature rise. Serious operating trouble is thus guarded against since in its event, the station will not operate after being shut down until inspection is made and the relays re-set.

An inverse phase and low-voltage induction type relay is provided and its contacts are shunted across the coil of shunt relay (3). In the event of this relay operating, its contacts shunt the coil of (3) and render it inoperative, thus preventing the station from starting. A second set of contacts (27) also shunt relay (3) and serve to shut the station down. They belong to relay (27), which is an underload time delay relay operating when the direct-current load falls off below a definite value for a predetermined time, from 3 minutes to 30 minutes, as may be desired.

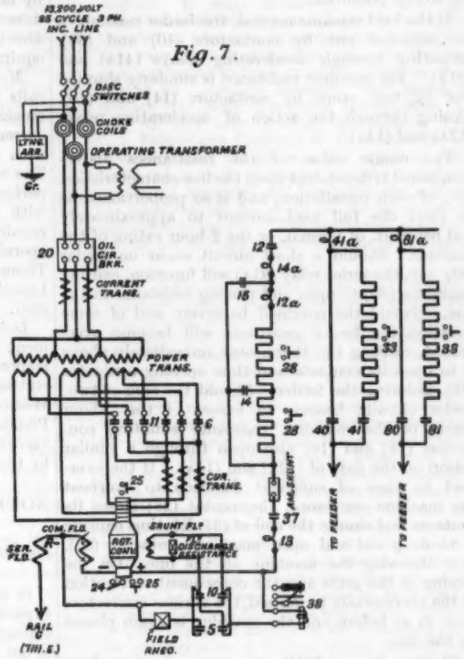
When the auxiliary bus (A–1) is energised, a third circuit is also closed through (26–R). This is a re-setting coil in the field reversal notching relay and serves to re-set it to the zero position if the relay has functioned in a previous step. Relay coil (26–R) is also taken through an interlock on contactor (6), the alternating current running contactor.

According to the usual Westinghouse method of starting, the shunt field is closed in the normal operating position, before starting voltage is impressed across the rotary. This is accomplished at the time the bus (A–1) is energised, in the automatic station, by potential being impressed across the coil of contactor (5). This contactor is the normal or correct field contactor, corresponding to the up position of the field switch in manual operation. Another contactor (10) corresponds to the down position of the same field switch. No. 5 is interlocked with this latter contactor so that it cannot close if (10) is in.

The operation of shunt relay (4) closes in the starting contactor (6), since its contacts are in series with the closing coil of the latter. The closing in of (6) impresses starting voltage across the converter, and it begins to turn over and speeding-up approaches synchronism. The next step in cutting in is to close in the running contactors and to ensure the correct polarity is obtained. Both these features are controlled by relay (7), which is one of the most important units in the equipment. This relay consists of a small motor with a permanent magnet field and a direct-current armature which is geared through a 200 to 1 reducing gear to a four-position drum. The motor armature is connected to the direct-current pilot brushes through resistance during the starting period, and as the potential across the commutator below synchronism is alternating, the motor armature will tend to oscillate but will not revolve. As soon as the converter pulls into step, direct current, is available and the motor starts in a direction dependent upon the polarity of the converter.

Assuming first, then, that correct polarity is obtained at first trial, the relay armature will rotate in a clockwise direction, making contact (A) first. This will impress potential across the closing coil of shunt relay (8) which locks itself in through a set of contacts in parallel with the (A) contacts in the relay (7), and also prepares a circuit for relay (19) when it functions in step (B). As the relay (7) drum swings over to step (B) it closes in relay (19), which is provided with three sets of contacts, one set of which is used as a holding circuit to lock the relay in, another shorts the closing coil of relay (4), thus causing the starting contactor (6) to drop out, while the third set energises the closing coil of shunt relay (11–X) through an interlock on the starting contactor. This interlock closes as soon as the latter opens, and the shunt relay (11X) is then energised. In closing it energises the closing coils of the running contactors (11), which now close in and impress full running voltage across the rotary. A second set of contacts on (11–X) also completes a circuit through the motor of the brush-lifting mechanism, and the brushes are then lowered.

Fig. 7.



Relay (8) is dropped out through being shorted by either contacts on the running contactor or by contacts (6) on relay (7) when it travels over to the "C" position.

Incorrect Polarity.—Should the converter come up with incorrect polarity, relay (7) rotates in a counter-clockwise direction, but making (A) contact as before and closing in relay (8). This relay completes its own holding circuit as before and closes a contact in series with the direct-current relay (9), which closes as (7) makes contact at (D), the next position on the drum. This relay completes its own holding circuit, opens the shunt field contactor (5) and closes in reverse field contactor (10). The drum of (7) still travelling in the counter-clockwise direction as rotary potential is falling to zero value, next bridges contacts "C" and "B," and causes (8) to drop out consequent upon the shorting of its closing coil. Since (9) is a direct-current voltage relay it drops out when the machine slips one-half pole and the voltage becomes zero and, dropping out, it releases (10), the reverse field contactor, and closes in (5) the normal field contactor, during which the machine slips the other half-pole and usually builds up in the right direction. The sequence is then the same as if the machine had built up with the correct polarity in the first instance. If, however, this manipulation of the field contactors (5) and (10), owing to improper adjustment of field relay (9) fails to correct polarity and more than one field reversal may be required, the same series of events is gone through three times. The repetition is fixed at three times since each time (9) opens, the notching relay (26–N) is energised, and on the third notch starting contactor (6) is opened and the board builds up as in the first place. The notching

relay is automatically re-set by (26–R) when (6) and (10) are in the open position at the starting period after shut-down.

Returning to where the running contactors were in and the brushes down, these two operations, through interlocks on the contactor (11) and the brush mechanism (31), complete a circuit which closes the alternating current shunt relay (37–X) through field current relay (38), which latter ensures full field strength. Shunt contactor (37–X) in closing energises the closing coil of main direct-current contactor (37) and this latter in closing energises, through a set of contacts, the direct-current contactor No. 12, which connects the machine to the feeder bus through preventative resistances. Contactors (41) and (81) are normally energised, and in the closed position through the grid thermostat contacts (41A) and (81A), directly by trolley potential.

If the load remains normal, the feeder resistances are shunted out by contactors (40) and (80), operating through accelerating relays (41A) and (81A). The machine resistance is similarly shunted out in two steps by contactors (14) and (16), closing through the action of accelerating relays (12A) and (14A).

The ohmic value of the resistances above-mentioned is dependent upon the line characteristics, &c., of each installation, and is so proportioned as to limit the full load current to approximately 150 per cent. of normal, or the 2-hour rating of the machine. Should a short circuit occur on feeder (80), say, the series relay (81A) will function, causing contactor (80) to open and placing resistance in the line. Should the overload be severe and of some duration the feeder resistance will become overheated, causing the thermostat immediately above it to open its contacts and thus opening contactor (81), isolating the feeder. Should the sum of two-feeder circuits become in excess of the 2-hour rating of the machine, resistance shunting contactors (14) and (16) also open through a similar action on the part of (12A) and (14A). If the overload be then of sufficient duration to overheat the machine resistance, thermostat (28) closes its contacts and shunts the coil of (37–X), thus causing it to drop out and open machine contactor (37), thus throwing the machine off the line. On the cooling of the grids and the consequent restoration of the thermostats to normal, the various contactors close in as before and the machine is again placed on the line.

Shutting Down.—While the station is started up by low trolley voltage it is shut down by the falling-off of current on light loads. This is accomplished in the following manner: When the load falls below a predetermined value, the amount of flux in the solenoid of relay (13) becomes insufficient to support the core of (13) which drops out and energises the motor of relay (27) which provides a time element of anywhere from 3 minutes to 30 minutes. This under-load delay relay consists of a motor driving through a gear train a vertical shaft upon which, at its lower end, is mounted a moving contact. The vertical shaft is not in one piece, but the lower end is engaged by a magnetic clutch, energised at the same time as the motor. The lower portion is also returned to the off position through a coil spring. This arrangement permits of the immediate re-setting of the relay should the demand on the station increase beyond the value at which relay (13) has been set for.

Relay (27) in closing its contacts shunts the closing coil of relay (3), thus opening it and breaking contacts (3) through which the auxiliary bus (A–1) is energised, and also a set of contacts (3) in series with the coil of shunt relay (37–X). This relay, opening, drops out the main direct-current contactor (37) and so disconnects the machine from the line. Contactor (37), in opening, breaks contacts in parallel with those of (3) through which the bus (A–1) has been energised, and thus renders dead the whole series of relays, contactors, &c., which have been closed in starting, clearing the station and making it ready to re-start. Load is broken first on the direct-current contactors, and the alternating current side stays in until (37) has been opened. Contacts on the main breaker close when it opens and thus energise the motor of the brush mechanism, lifting the brushes. When they are lifted, contacts interlocking in this circuit, on the brush mechanism interlock drum, are broken, thus stopping the motor.

Aside from the bearing thermostats, the over-speed device and "C.O." relay protection on the high tension, several other protective features are incorporated. Thus across the coil of (3) are shunted contacts (32) and (18), a direct current reversal current relay and a reverse phase and low-voltage relay respectively. These relays definitely preclude the possibility of starting up the station while these conditions persist.

Auxiliary Apparatus and Equipment.—The station equipment is effectively grounded through the medium of a ground pit accessible through the basement floor and provided with a water supply. Pipes are driven to refusal, and connected together by heavy copper strap. The air compressor drives directly off the feeder bus by means of a 550-volt direct-current motor, which is used for blowing-out equipment.

Metering.—The metering of an automatic station calls for rather complete equipment. As a check on station performance, a Westinghouse alternating-current graphic wattmeter is installed together with a direct-current Bristol recording voltmeter. The wattmeter gives a complete record of station performance, while the voltmeter connected as it is with the feeder bus, gives a check record when required to compare voltage variation with station operation. In addition to these two meters, a Thomson polyphase integrating wattmeter and a Lincoln maxicator are installed for metering the load.

Design and Installation.—The engineering department of the Toronto Hydro-Electric System is responsible for station lay-out and design of the station. The equipment was manufactured by the Westinghouse Electric Manufacturing Company, Pittsburgh, Pa.; the installation of equipment except for high-tension conductors, &c., being done by the Canadian Westinghouse Company.

NOTE ON THE FLOW OF AIR AND STEAM IN NOZZLES.

By GERALD STONEY, D.Sc., F.R.S., and NORMAN ELCE, B.Sc. Tech.

IT is now generally recognised that steam when expanded rapidly, as in turbine nozzles, becomes supersaturated provided that the initial superheat is not so high that the steam remains superheated throughout the expansion. Whether any condensation takes place before the nozzle throat is not so definitely known, but some evidence on this point is afforded by the following note on discharge coefficients.

If the theory of supersaturation be correct, the expansion of steam through a nozzle is so rapid that condensation cannot take place down to a pressure below the critical pressure, so that down to the throat the steam expands as a perfect gas. The law of expansion is then:

$$p\,(V - b)^{\gamma} = \text{a constant} \quad . \quad . \quad (1)$$

where

$\gamma = 1{\cdot}3$

p = absolute pressure

V = specific volume

b = co-volume, taken as the specific volume of water at 32 deg. F.

The co-volume b is only 1 per cent. of the specific volume V at pressure $p = 300$ lb. per square inch, and neglecting this the maximum theoretical discharge of steam through a nozzle may be shown to be

$$q_{max.} = 0{\cdot}3155\, a_t \sqrt{\frac{p_1}{V_1}} \text{ lb. per sec.} \quad . \quad . \quad . \quad (2)$$

Where

$q_{max.}$ = maximum theoretical discharge, lbs. per sec.
a_t = nozzle throat area, sq. in.
p_1 = initial pressure, lbs. per sq. in.
V_1 = initial volume, cub. ft. per lb.

The effect of the small term b neglected here is only 0·274 per cent. of the discharge at a pressure $p_1 = 300$ lb. per square inch absolute. The value of V_1 to be inserted in equation (2) is in each case the specific volume of the steam at inlet, whether superheated or wet.

For saturated steam, equation (2) may be written in the convenient form:

$$Q_{max} = M_1\, a_t\, p_1 \text{ lbs. per hr.} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Where:

$Q_{max.}$ = maximum theoretical discharge, lbs. per hr.
M_1 = a constant depending upon p_1 and upon the index in the adiabatic equation, which is here taken as 1·3, the value for dry steam.

Rateau (Recherches experimentales sur l'ecoulement de la vapeur d'eau) measured the discharge of saturated steam through convergent nozzles, and found the empirical equation:

$$Q_{max.} = 3600\,(15{\cdot}26 - 0{\cdot}96 \log. p_1)\, a_t\, p_1 \text{ gms. per hr.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Where

a_t = sq. cms.
p_1 = kgs. per sq. cm.

In English units this becomes:

$$Q_{max} = 3{\cdot}456\,(17{\cdot}05 - \log. p_1)\, a_t\, p_1 \text{ lbs. per hr.} \quad (5)$$
$$= M_2\, a_t\, p_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Where

a_t = sq. in.
p_1 = lbs. per sq. in.
M_2 = a constant depending upon p_1

Table I shows values of M_1 for $\gamma = 1{\cdot}3$ (the index for dry steam) and $\gamma = 1{\cdot}135$ (the index for saturated steam), and of M_2, for various values of p_1.

If the limit of the supersaturation condition is such that no condensation occurs before the throat, the ratio $\frac{M_2}{M_1 \text{ (for } \gamma = 1{\cdot}3)}$ is the coefficient of discharge C_d, for saturated steam in Rateau's convergent nozzles, and this should then be of the same order in this case as for any perfect gas, such as air or highly superheated steam, through similar nozzles.

Table II shows the comparison of the coefficient

$$\frac{M_2}{M_1 \text{ (for } \gamma = 1{\cdot}3)}$$

with

1. The coefficient of discharge of air through a convergent nozzle from the experiments of T. B. Morley. (Proc. I.M.E., January, 1916.)

2. The coefficient of discharge of highly superheated steam through a convergent nozzle from the experiments of A. L. Mellanby and W. Kerr. (Trans. Inst. Engineers and Shipbuilders in Scotland, December, 1920.)

It is thus seen that the coefficient of discharge for saturated steam is, according to Rateau's tests,

TABLE I.

p_1		300	250	200	150	100	50	14·689	10	5	1
M_1	$\gamma = 1{\cdot}3$	52·12	52·39	52·73	53·16	53·83	55·02	57·25	57·93	59·46	62·34
	$\gamma = 1{\cdot}135$	49·64	49·91	50·22	50·63	51·23	52·41	54·54	55·22	56·64	59·33
M_2		50·37	50·65	50·98	51·42	52·02	53·06	54·90	55·49	56·52	58·93

TABLE II.

Medium.	Reference.	Initial pressure, Pounds per Square Inch Absolute.						
		150	100	75	50	25	10	1
Saturated steam	Rateau .. C_d	0·967	0·966	0·965	0·964	0·962	0·958	0·945
Steam at 250 deg. F. superheat	Mellanby .. C_d	—	—	0·975	—	—	—	—
Air	Morley .. C_d	—	—	0·97	0·97	0·97	—	—

slightly less than that for air and superheated steam, which are about the same. On the other hand, Rateau's nozzles were not all so well shaped as those tested by Mellanby and Morley, so that the evidence, although not quite conclusive, is that there is little or no condensation in the expansion of saturated steam in a nozzle down to the critical pressure ratio. It would be an interesting investigation to determine the coefficients of discharge for steam initially wet, saturated and superheated, and for air, through the same nozzle, and thus determine whether there is any condensation before the throat with wet or saturated steam. So far as the above evidence goes, there is no such condensation, and saturated steam acts down to the throat as a perfect gas with an adiabatic index of 1·3.

NOTES ON NEW BOOKS.

WHEN, a few years before the war, the German giant steamers Imperator and Vaterland were projected, and suggestions were invited for securing adequate fire-security on board, civil engineer H. Pohlmann, of Hamburg, proposed to separate two wooden walls by an air space subdivided by a partition of a light ferro-concrete. The fire tests made at Kiel proving satisfactory, some of the cold storage hatches on the Ems were first built on this plan, whilst in others the air spaces were packed with charcoal. As the new insulation was quite equal to the old, further progress was made in the construction of cellular air spaces between sheets or wall of paper, wood and a light ferro-concrete. There was, of course, nothing new in the utilisation of the well-known high insulating capacity of dry air. The novelty of the method evolved by H. Pohlmann, now dealt with in his book on "*Thermosbau*" [Berlin, Julius Springer, 32 marks], is his subdivision of the air space into many small cells, in which the air remains stationary; an air space through which air can circulate has no thermal insulation value, and is liable to harbour dust, condensed moisture and insects. Scientifically, Pohlmann had the assistance of Professor Oscar Knoblauch, of Technical Experimental Station at Munchen. His pamphlet of 92 pages describes and fully illustrates the adaptation of the Thermosbau to various purposes; the detailed drawings, which take up many of the pages of the octavo book, are in fact quite unusually explicit. Thermos construction found its first adoption on board ship, for deck, bulkheads, doors, storage rooms, boiler shafts, light partition walls, radiotelegraphic boxes, &c. A large number of ships have been fitted up with thermos structures, and the book under notice shows how the thermos wall is connected to the ship's walls, plates and beams, &c. For cold storage buildings the cost is said not to exceed the ordinary rates. Thermos dwelling-houses have also become popular.

Blue-printing and other similar methods of copying drawings and documents has become such an important part of any establishment where designing is an essential part of a firm's work that equipments capable of turning out hundreds of prints per day are in operation, and such equipment may consist of continuous printing apparatus with its electric lamps, drying ovens and other accessories. A plant of this kind requires expert attention and wide knowledge of a varied character. To assist those responsible for such a department, Mr. B. J. Hall, M.I.Mech.E., has written a very able and complete treatise, "*Blue Printing and Modern Plan Copying*," which is published by Sir Isaac Pitman and Sons, Limited, price 6*s.* net. Mr. Hall, from his extensive and practical business experience, is able to place before his readers much information rendering the path of the engineers' and architects' photo-printer free from pitfalls. He deals with the principal processes (including a chapter on the photostat), and also illustrates the various types of plant and the lay-out of printing rooms. A very considerable portion of the book is devoted to the black-line—or true-to-scale—process, and although the directions are ample and voluminous, the author wisely recognises the delicacy of some of the operations and the value of a practical lesson for anyone who thinks of installing and operating such a plant. By consulting Mr. Hall's book, however, the manager of a photo-printing department will be enabled to add much to the usefulness and efficiency of his work.

The motor car has made many people take an active interest in roads and road construction who would, in former days, have been satisfied with occasionally grumbling at the bad roads. At present a little book like the "*Landstrafsenbau*," of A. Liebmann [Berlin and Leipzig, Vereinigungwissenschaftlicher Verteger, Walter de Gruyter and Co., price 2·10 marks, plus 100 per cent.] which now appears in its second edition, may find a fairly wide circle of readers. The little publication of 138 pages, of pocket-book size, deals in a concise, technical manner with the construction of roads (as distinct from streets) in the country, on mountains and in forests, their drainage, tarring, the arrangement of tracks for vehicles, friction on roads, &c., giving some bibliographic references, but limiting itself largely to Continental conditions in Germany and Austria. Many points are touched upon. One feature that is not discussed, and which yet exercises people a good deal just at present, is the question upon whom the responsibility for maintaining the roads should fall. In the last century it was fair to saddle the district with the road maintenance; in our days, when a drive of 100 miles is quite an ordinary thing, that is no longer fair; but the tax on motor cars yields millions for the purpose.

In view of the high degree of perfection reached by the Italian industry in all its branches, and also of the great interest which surrounds that country's researches in every field of technics—and in this connection we bear in mind particularly metallurgy, engine construction and shipbuilding, with which we deal more especially—a new Italian technical dictionary is always welcome. Such a dictionary is entitled "*Italian Technical Words and Phrases.*" It measures 6 in. by 3 in. The English-Italian portion has 150 pages, followed by an equal number of pages for the Italian-English part, and the words and terms translated in both languages apply not only to the industries we refer to above, but to practically every trade and profession, also to commerce, arts and sciences. The book is well printed, and appears to us to be very complete, notwithstanding its small bulk. It is edited by Mr. E. F. Paventa, and is published at the price of 6*s.* net by Messrs. E. Marlborough and Co., 51, Old Bailey, E.C. 4.

That the policy of organised labour during the past twenty-five years has been singularly deficient both in foresight and insight is demonstrated once again in "*A New Policy for Labour*," which is a small book written by Mr. Hilderic Cousens, and published at 5*s.* net by Mr. Cecil Palmer, London. Unfortunately, though the author appears to be fairly well acquainted with the labour side of industrial matters, he is often grotesquely inaccurate in many of his statements concerning the other partners in industry. Indeed, even on the labour side he is under the delusion that the demand for high individual skill is diminishing. As a matter of fact, in the tool room of a large factory the standard of skill demanded is continually being raised, but nowadays we do try and avoid the uneconomical use of "razors for cutting whetstones," that is to say, employing a highly-skilled and highly-intelligent craftsman, on routine repetition work. The excellence of a first-class mechanic is mainly a matter of brains, and these brains can be better employed than in running machines which an unskilled girl can, with a few weeks' training, learn to operate efficiently. The author indulges freely in prophecy, and affirms that unless his "new policy" be adopted labour will be reduced to serfdom and that a new world war will be inevitable. Curiously enough this new policy is nowhere explicitly stated, the reader being referred for details to articles by a certain Major C. H. Douglas. From the context, however, the policy would appear to be in the main a revival of the "soft money" movement which found such strong advocacy in America after the war of secession. During this period workmen and others were, as during the late world war, paid at rates which on the then existing gold basis were on the whole in excess (at times very much in excess) of the gold value of their wages in normal times. To this end it was necessary to borrow the equivalent of gold, and in our own case the standard was maintained by commandeering dollar securities. Labour gained greatly thereby. The suggested policy appears to be that repayment should be made in paper with an exchangeable value far below par. Like causes produce like effects, and it is therefore not surprising that history should repeat itself, and that there should be a recrudescence of this "soft money" policy here. The author's competence as an authority on such matters can, however, best be gauged by the following quotation: "One pet delusion of the English public . . . is that this country has been impoverished by the war." An author who is capable of believing that this is a delusion must either be condoled with on his imperviousness to what McAndrew called "sevidential facts" or congratulated on the strength of his volition. Possibly, like the white Queen in "Alice, through the Looking Glass," he has practised believing six impossible things in the morning before breakfast.

The experiments of Stanton and Pannell provided the requisite data for calculating the loss of head in the pipe lines used for conveying oil from the wells to the seaboard, and also for distributing oil from storage tanks to furnaces. On the basis of these experiments, Mr. R. S. Danforth, Assoc.M.Am.Soc.C.E., has prepared a series of charts, giving at sight the discharge from certain standard sizes of pipe corresponding to different hydraulic gradients and to different viscosities and specific gravities of the oil. Another chart shows the relationship between the absolute and the practical measures of viscosity adopted in different countries, and two remaining charts show the expenditure of power necessary to ensure stated daily deliveries. The charts are published by the King Knight Company, San Francisco, at 3 dols. the set.

Pure mathematicians frequently express dismay at the type of mathematical text-book which finds favour with the student of engineering. They fail to bear in mind that the engineer intends to use mathematics as a tool, and so long as the formulas he is presented with give correct results it is a matter of indifference to him whether or not flaws can be found in the demonstrations of them with which he may be supplied. It may, moreover, be noted that the demonstrations now denounced were for many decades accepted as adequate by professional mathematicians. The view that mathematics interests the engineer as a tool seems to have guided the authors of a short treatise on "*Analytic Geometry*," just issued by the McGraw-Hill Book Company, Incorporated, at 15*s.* net. In this little treatise the authors, Professor C. I. Palmer and Professor W. C. Krathwohl, seem to meet very fully the needs of the engineering student. Great use is made of graphs, and the many exercises in plotting suggested will familiarise the student with the essentials of the study in the most informative and effective manner. The concluding chapters of the volume are devoted to the elements of the calculus.

One of the crying needs of the age is a more widespread knowledge of human history. Writers on social and political subjects are prone to compare existing conditions with an imaginary Utopia, very materially to the disadvantage of "things as they are." Were, however, the economic and social conditions of to-day compared with those of the past, even the thickest skull could not fail to be penetrated by the conviction that no class of the community has benefitted more by the rise of capitalism than the so-called proletariat. Of course, the improvement in social and economic conditions did not begin with the inventions of Watt, which are commonly taken to mark the commencement of this age of energy. At no long distance of time, geologically considered, our ancestors were on a par with the naked and chronically starving inhabitants of Tierra del Fuego. From that status, thanks mainly to the discoveries of individual men of genius, we climbed to barbarism and thence to such civilizations as those of ancient Babylonia and Egypt. Throughout, progress depended mainly on the increasing control of the great powers of Nature, which resulted from the introduction of improved tools. In a capital little treatise, entitled "The Tools of Man," published at 2*s.* 3*d.* by Messrs. Hodder and Stoughton, Ltd., these are reviewed by Mr. John Hill, principal of the Shoreditch and Bethnal Green Day Continuation School. In his opening chapter the author lays stress on the hard life lived by the primitive races of mankind, and sketches the improvements effected by the many great inventors of the past whose very names are unknown to us. He gives slight but informing sketches of Babylonian, Egyptian and classical civilisations, but he appears to award to the Arabian heirs of Greek culture rather more than their due credit. The Arabs are commonly considered to have added remarkably little to this inheritance, and the invention of the numeral zero with which Mr. Hill credits them was we believe, learnt by them from India. A short but interesting account of the mediæval guilds follows, and in Part II of his little treatise Mr. Hill deals with the coming of the factory and the consequent industrial revolution, which has so enormously improved both the moral and material status of the "common people." The little work is written on excellent lines throughout, and accurately represents the more essential facts.

There is an old proverb to the effect that a cobbler should stick to his last, and had this adage been borne in mind by the author of "*The Steam Turbo-Alternator*," published by Sir Isaac Pitman and Sons, Limited, at 15*s.* net, we should have been able to write a much more appreciative notice of the book than regard for our readers, will, as matters stand, permit. The author of the work in question is Mr. L. C. Grant, A.M.I.E.E., and the first part of this treatise is devoted to the steam turbine. Apparently he has had some experience in the operation of this form of prime mover; and certain notes based on this experience are of value and, it may be added, that his descriptions of mechanical details appear clear and accurate. On theoretical matters, however, the author is most misleading. We may instance the following observations on reaction turbines:

" Full boiler pressure and superheat, if any, is admitted to the annular passage before the first row of guide blades. The function of these blades is not the same as with an impulse turbine, but is primarily to guide the steam at the correct angle into the first row of moving blades so as to avoid any sudden change of direction of the flow." The author resurrects, moreover, Zeuner's inaccurate and irrational expression for the specific volume of superheated steam, a formula which most turbine designers have relegated to an innocuous desuetude. On another page he estimates the mechanical losses in bearings, gearing, &c. to be from 5 per cent. to 10 per cent., the correct figure being somewhere about 1 per cent. in the case of turbines of any reasonable size, and in very large machines the figure may fall much below this figure. In the electrical portion of the book the author is more at home, and this section will prove useful and informatory to young station engineers.

Perhaps nothing impresses us more with the amazing rapidity of technical progress in our age than the recognition of the fact that industries and appliances which were unknown in the school and college days of the older generation have already achieved finality, though improvements, of course, continue to be effected. That the electric motor and power transmission, the glow lamp and telephone are not as old as gas lamps and railways is hardly realised by the students of our day. Even electric train haulage is considered to have reached a certain maturity. The advantages of using electric power and light underground were manifest, but the difficulties and risks are great; hence a somewhat slow development in this branch. The first Saxon colliery of Zauckerode, which introduced electric energy underground to drive a fan and to pull trucks in 1882, also installed the first large electric machinery set of the Ilgner type in 1914. Meanwhile, Ward-Leonard machinery had spread from America. Professor W. Philippi, of Siemensstadt, near Berlin, who writes on "*Elektrische Fördermaschinen*" (Leipzig, S. Hirzel), was known as author of several volumes on electric haulage, its economy and on its safety appliances. He deals in the volume before us mainly with the electric features on general, not on too mathematical, lines; he discusses rope-slip, but does not mention rope breakage. His comparative cost estimates are admittedly uncertain in view of the troubled times, and it may be characteristic and not merely oversight, that the publishers do not name any price on the copy they have sent us. With the various extras now charged, however, the nominal price of a German book means little at present.

The principles of office administration, whether they are concerned with the handling and filing of records, or with the control of the human element are not matters about which there can be much difference of opinion. Order, neatness and systematic methods are the essentials on the one hand, and discipline, tact and commonsense on the other. The application of these principles will, however, differ very largely, even between well-managed offices, for tradition, custom and the personality of the man in charge, count for more than considerations of theoretical perfection. The words of Alexander Pope, " For forms of government let fools contest—whate'er is best administered is best," are as true of an office as of an empire. In "*Architectural Office Administration*," by Francis Lorne, A.R.I.B.A. (Technical Journals, Limited, Westminster, London, 1921, price 5*s.* 3*d.* net), the author deals generally with the subject, and also gives examples of practically all kinds of forms used to facilitate and systematise the keeping of records, both technical and financial. We should have been pleased if the author had seen his way to discourage the absurdly illegal style of lettering used by architects in the titles of their drawings. It is a spurious attempt at art, and in any business office it should be replaced by the bold characters employed for similar purposes in engineer's drawing offices.

RECONSTRUCTED ROAD ROLLERS.—In view of the high cost of such plant at the present time, the Oxford Steam Plough Company, Limited, of Cowley, Oxford, have extended their facilities for the repair and reconstruction of road rollers, traction engines and similar vehicles, and an interesting display of two such reconstructed steam rollers was made by the firm at the recent Public Works, Roads and Transport Exhibition at the Agricultural Hall. One of the machines was a 10-ton Aveling roller, over thirty years old, and the other was a Wallis 5-ton tractor converted into a 7-ton roller. Both machines appeared excellent jobs and did great credit to the original builders and the re-builders. The Oxford Plough Company have recently introduced a system of repairing worn link motion by which the holes are ground and ground pins fitted. The grinding is done after hardening, so that no allowance has to be made for warping. Another special feature of this repairing work is the firm's system of steel-plating worn roller wheels.

THE NORDBERG WINDING ENGINE.

(Concluded from page 695.)

IN our first article dealing with the Nordberg winding engine, at the " Old Abe " pit, Lead, South Dakota, of the Homestake Mining Company, we stated (page 566 *ante*) that this hoist was controlled by three levers, each with two movements. The position of these levers was shown on the plan of the operating platform, given in Plate XXXIII with our issue of October 21. It was then explained that one lever operated the throttle and reversing mechanism and each of the others a clutch and a brake. We will now deal with this part of the machine in greater detail, and for the purpose give diagrams in Figs. 91 to 94, annexed, and Fig. 95, on the opposite page, the latter showing an outline elevation of the engine with the operating gear drawn in in full, so as to enable the description to be followed more easily.

The operation of the hoist is throughout by servo-motors. Six such motors are arranged, two for the throttle and reverse gear, two for clutches, and two for the brakes. The first two are placed towards the centre of the machine, between the two pairs of engines. The clutch motors are outside and close to the clutch and brake drums, while the brake motors are the furthest out of all (Fig. 95). In order to make the method of operation clearer we have reproduced isometric views of the essentials of the gears, while it will further assist our readers if they will refer back to the previous articles which, with the drawings and photographs then reproduced, of the whole engine, brakes, clutches and valve gear will enable them to trace the positions and connections of the parts we are about to deal with.

Considering first the throttle and reverse gears, these are controlled, as stated above, by a single lever having two movements, *i.e.*, forwards and backwards, and to either side. These are depicted at the right-hand upper corner of Fig. 91. The lever movement at right angles to the crank (forwards and backwards) controls the throttles, the sideways movement controls the reversing gear. The hand lever is pivotted on a bracket having a hollow boss through which passes a rod coupled to a light rocking shaft. The rocking shaft is linked up with the servo-motor (as shown in Fig. 95), operating the throttle. This motor, which is the one just to the right of the centre line of the engine in Fig. 95, is single-acting. The admission of air to the motor cylinder lifts the weighted arms shown in Fig. 91, and these through the shaft and four keyed arms, operate the valves themselves. It will be remembered that throttles are provided both for the high pressure and the low-pressure cylinders so that there are four in all. Coupled to the weighted arms are also the necessary rods for the floating lever of the servo-motors. The throttles are closed by the weighted arms shown in Fig. 91.

The second movement of the operating lever is to the floating lever of the motor just to the left of the centre line of the engine (Fig. 95). The motor and the

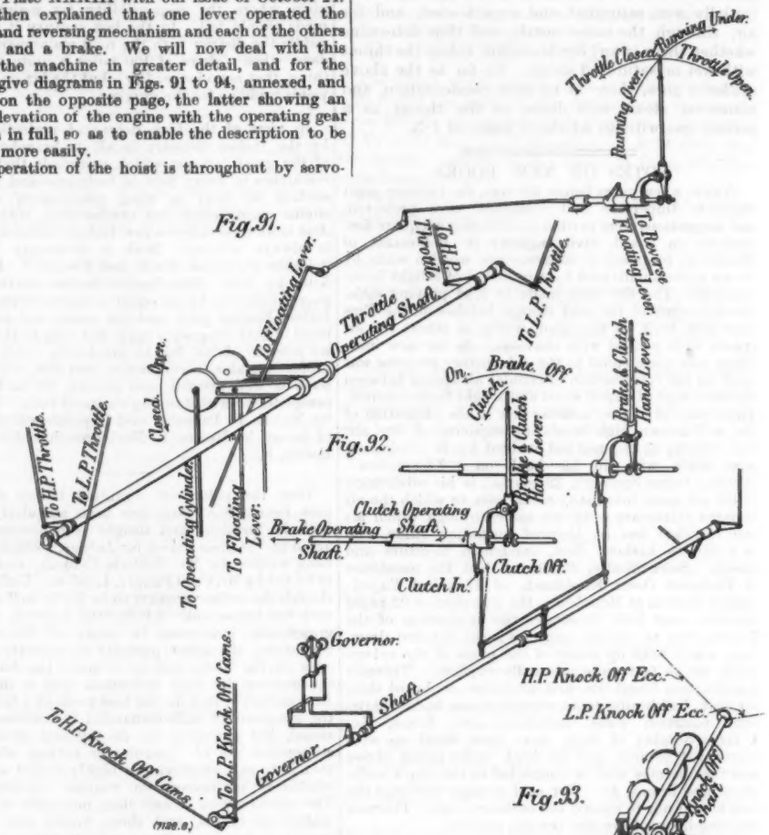


Fig. 91.

Fig. 92.

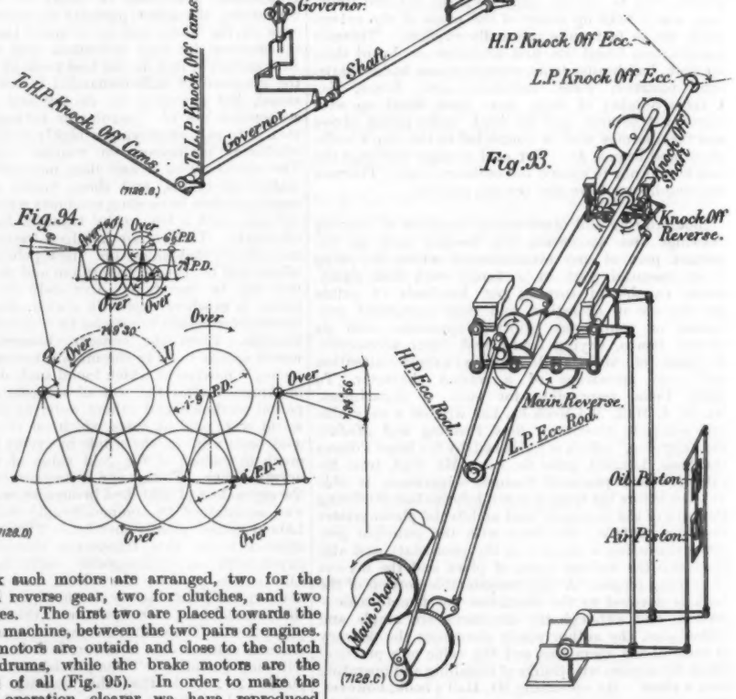


Fig. 93.

Fig. 94.

COMPOUND WINDING ENGINE FOR THE HOMESTAKE MINING COMPANY.

CONSTRUCTED BY THE NORDBERG MANUFACTURING COMPANY, MILWAUKEE, WIS., U.S.A.

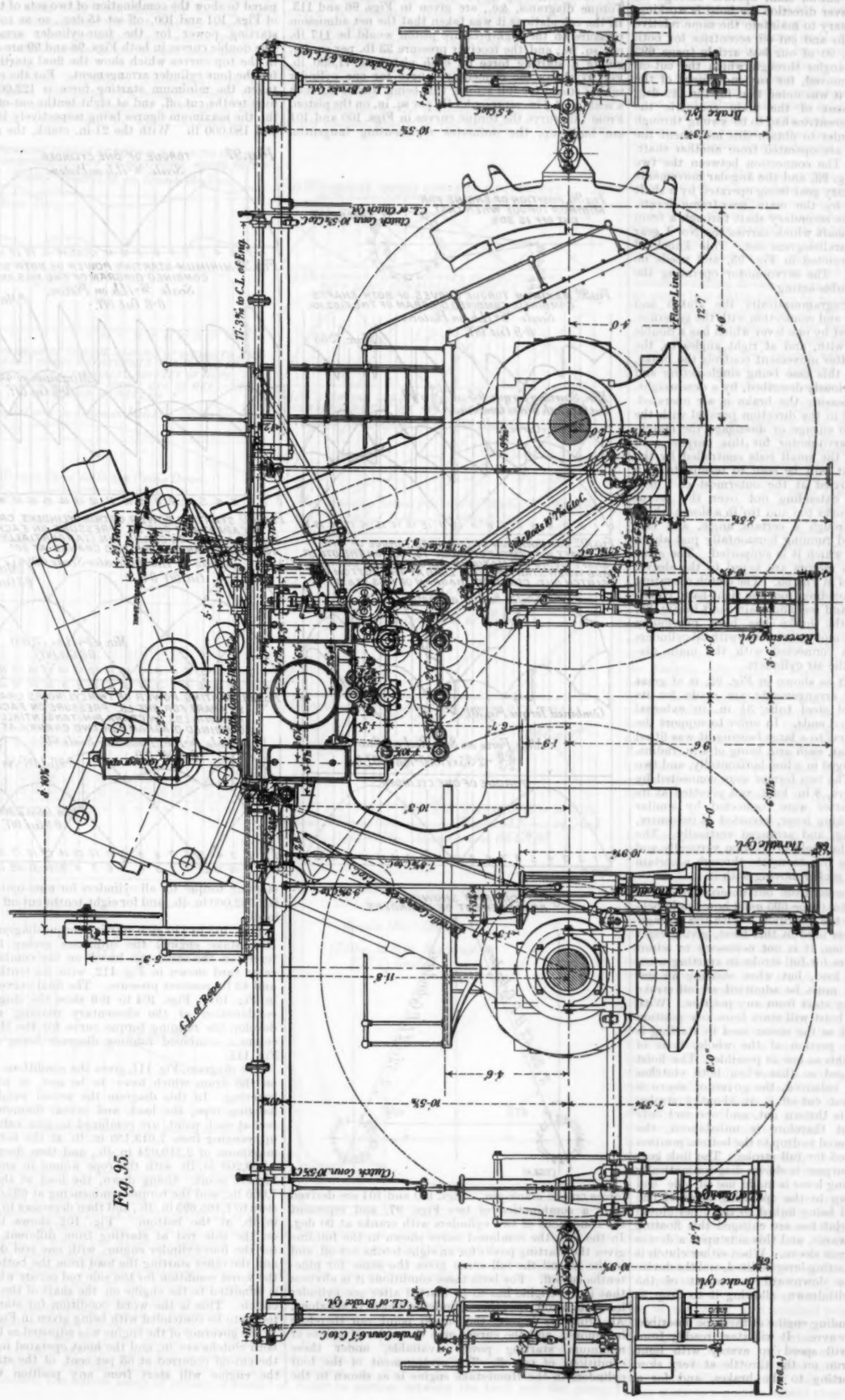


Fig. 95.

reversing gear are depicted in Fig. 93. This figure shows how the motion of the main shaft is transmitted to the valves. The main shaft is fitted with a gear wheel which drives another gear of equal size on a lay shaft carried on brackets. This lay shaft has two small cranks at 90 deg., at its ends, and the latter, by means of light coupling rods operate similar cranks on a secondary shaft above (Fig. 93). These rods and cranks can be easily followed in Fig. 95. The secondary shaft is carried in fixed bearings, but carries a gear wheel which meshes with a second gear carried in a swinging frame. The latter also carries a third gear driven by the second, and in turn driving a fourth which is on the main eccentric motion shaft. This shaft carries eccentrics for the four cylinders, one end of the shaft only being shown in Fig. 93. The swinging frame is used for varying the position of the main eccentrics relative to the crank, in order to change the direction of motion of the hoist. This is accomplished by distorting the parallelogram frame and thus swinging the gears through the angles shown in Fig. 94, without disturbing contact of the gears. In this particular instance, as stated in our last article, a circular displacement of 149 deg. 30 minutes of the shaft carrying the eccentrics is required to reverse, and this is obtained as indicated in Fig. 94, by a movement of the frame through 34 deg. 56 minutes. The frame and the manner in which it is hung are well shown in Fig. 95.

The engine being fitted with auxiliary eccentrics operating the trip or knock-off gear for the valves, it is essential, in order to secure efficiency in both

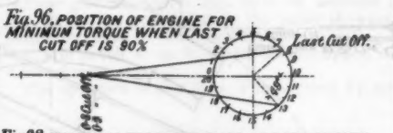
directions that the cut-off shall operate through its full range, in whichever direction the hoist is working. It is therefore necessary to maintain the same relative positions of the main and cut-off eccentrics for both directions. On Fig. 90 of our last article (page 695 *ante*) we gave the angles through which the cut-off eccentrics must be moved, for any movement of the main eccentric, and it was noted that for the 149 deg. 30 minutes movement of the main eccentric the auxiliary or cut-off eccentrics had to be swung through 40 deg. only. In order to obtain this movement the auxiliary eccentrics are operated from another shaft, by a similar gear. The connection between the two gears is shown in Fig. 93, and the angular movements in Fig. 94, the auxiliary gear being operated by a shaft and crank worked by the main gear-frame levers. The drive is from the secondary shaft through a train of three gears to a shaft which carries the No. 1 gear of the auxiliary parallelogram set. This knock-off reverse is clearly depicted in Fig. 93, and needs no further explanation. The servo-motor operating the reversing gear is double-acting.

Fig. 92 shows diagrammatically the clutch and brake operating gear and connection with the governor. Each reel is controlled by one lever which has a double movement, parallel with, and at right angles to, the main shaft. The latter movement controls the brake, the servo-motors in this case being single-acting and the brake set as previously described, by a deadweight. The servo-motor releasing the brake is air operated. The lever movement in the direction parallel with the main shaft serves to engage or disengage the clutch, by operating the servo-motor for this purpose. In Fig. 95 the ends of the small rods controlled by the first lever movement will be seen to terminate in a small bell crank carried at the outermost end of a tubular framework extending out over the servo-motors. This rod works too and fro' in a sleeve which can be revolved through a certain angle, and this sleeve will be noticed running horizontally just above a tubular beam, by which it is supported. The arms operating the clutch motors are keyed to the sleeve, and will be recognised in Fig. 95. The clutch operating shaft will be seen extending from the right-hand clutch motor to the right-hand reel and main shaft in Fig. 95. The operation of the brake has been previously described. All servo-motors are fitted with oil cylinders with rocking valves connected with the main distribution valves on the air cylinders.

The governor shaft as shown in Fig. 92, is of great length, and special arrangements are made for its suspension. It is of steel tube, 3½ in. in external diameter, with reduced ends. In order to support the centre without recourse to a large bearing, it was fitted with a four-armed star, each arm being of 4-in. radius. Two arms were arranged in a line horizontally, and two in line vertically. The two former were connected by links to a beam above, 8 in. long, and pivotted at its centre. The two latter were connected by similar links to another rocking lever, pivotted at its centre, with arms 4 in. long, and arranged vertically. The governor shaft was thus held in position vertically and horizontally, but was free to rotate through a certain angle, the beam and rocker moving with it.

It will be remembered from our description of the valve gear, Fig. 88, &c. (page 695 *ante*) how the knock-off gear is coupled to the governor. With the arrangement of four cylinders used in this hoist, giving eight impulses per revolution, it is not necessary to admit steam to the cylinders for full-stroke in starting when hoisting a balanced load, but when starting an unbalanced load steam must be admitted at full stroke so that the hoist may start from any position. With a balanced load the hoist will start from any position with a ⅛ cut-off, and as the steam used in starting is a very considerable portion of the whole, it is of importance to keep this as low as possible. The hoist was therefore arranged so that when both clutches are in and the load balanced, the governor sleeve is lifted and the earliest cut-off is at about ⅛ stroke. When either clutch is thrown out, and one reel only used, and the hoist therefore is unbalanced, the governor sleeve is allowed to drop to the bottom position and steam is admitted for full stroke. The link gear introduced for this purpose is shown diagrammatically in Fig. 92. A floating lever is made use of, one end of which is linked up to the operating lever of one clutch, the other end being linked to the other clutch lever. When both clutches are engaged this floating lever is forced downwards, and this acts upon a device which lifts the governor sleeve. When either clutch is out, one end of the floating lever is lifted, and the device which obstructs the downward movement of the governor sleeve is withdrawn, allowing it to drop to the bottom.

A four-cylinder winding engine of the type described is very easy to manœuvre. It will start readily from any position and will speed up evenly with light drums. It can be run on the throttle at very slow speeds without resorting to the brakes, and for a powerful engine the cylinder sizes are moderate. Torque diagrams, &c., are given in Figs. 96 and 113. In the calculations it was taken that the net admission pressure on the high-pressure piston would be 117 lb. per sq. in., and the receiver pressure 33 lb. per sq. in., giving a starting force on each piston of 71,000 lb. Fig. 97 shows the elementary curve for one cylinder taking steam for full stroke, this being drawn to such a scale that ⅛ in. represent 1 lb. per sq. in. on the piston. From this curve the torque curves in Figs. 100 and 101 are built up, the ordinates representing tangential



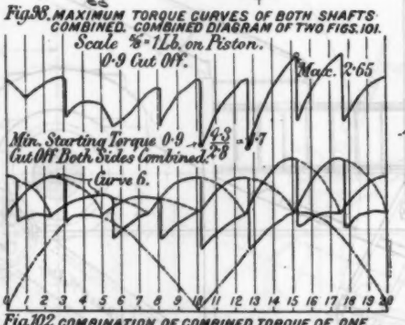


Fig.98. MAXIMUM TORQUE CURVES OF BOTH SHAFTS COMBINED. COMBINED DIAGRAM OF TWO FIGS. 101.
Scale ⅛"=1 Lb. on Piston.
0·9 Cut Off.
Max. 2·65
Min. Starting Torque 0·9 Cut Off Both Sides Combined. 2·8
Curve 6.

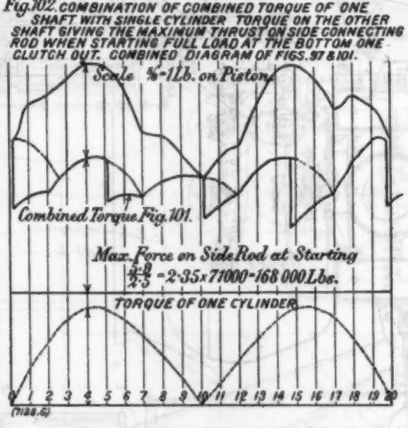
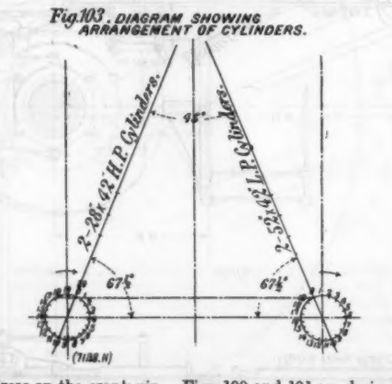
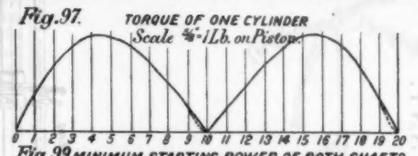


Fig.102. COMBINATION OF COMBINED TORQUE OF ONE SHAFT WITH SINGLE CYLINDER TORQUE ON THE OTHER SHAFT GIVING THE MAXIMUM THRUST ON SIDE CONNECTING ROD WHEN STARTING FULL LOAD AT THE BOTTOM ONE CLUTCH OUT. COMBINED DIAGRAM OF FIGS. 97 & 101.
Scale ⅛"=1 Lb. on Piston.
Combined Torque Fig. 101.
Max. Force on Side Rod at Starting
2·8/2·2 = 2·35 × 71000 = 168 000 Lbs.
TORQUE OF ONE CYLINDER



forces on the crank-pin. Figs. 100 and 101 are derived from a combination of two Figs. 97, and represent the conditions of two cylinders with cranks at 90 deg. In the first the combined curve shown in the full-line gives the starting power for an eight-tenths cut-off, and in the second the full curve gives the same for nine-tenths cut-off. For both these conditions it is obvious that if the engine has to be started after one cylinder has just cut-off, the other cylinder will have to act alone. All ordinates beyond the cut-off point can therefore be ignored, and the curves give the series of points of minimum starting power available, under these conditions of cut-off. The arrangement of the four cylinders in the Homestake engine is as shown in the diagram Fig. 103, and Figs. 98 and 99, have been prepared to show the combination of two sets of the curves of Figs. 101 and 100, off-set 45 deg., so as to give the starting power for the four-cylinder arrangement. The double curves in both Figs. 98 and 99 are combined in the top curves which show the final starting power for the four cylinder arrangement. For the conditions taken the minimum starting force is 122,000 lb. for nine-tenths cut-off, and at eight-tenths cut-off 101,000 lb., the maximum figures being respectively 188,000 lb. and 180,000 lb With the 21-in. crank, the minimum



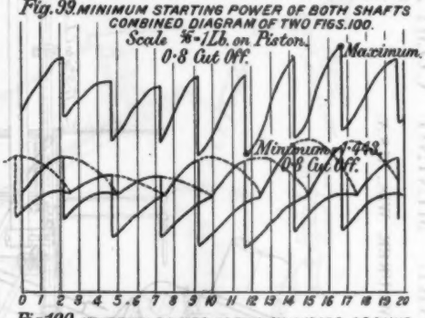


Fig.99. MINIMUM STARTING POWER OF BOTH SHAFTS COMBINED. DIAGRAM OF TWO FIGS. 100.
Scale ⅛"=1 Lb. on Piston.
0·8 Cut Off.
Maximum.
Minimum 1·443
0·8 Cut Off.

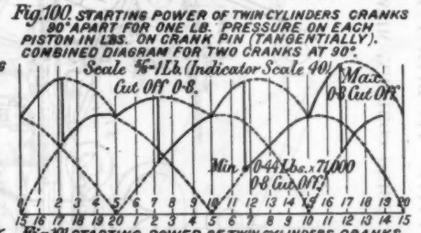


Fig.100. STARTING POWER OF TWIN CYLINDERS CRANKS 90° APART FOR ONE LB. PRESSURE ON EACH PISTON IN LBS. ON CRANK PIN (TANGENTIALLY). COMBINED DIAGRAM FOR TWO CRANKS AT 90°.
Scale ⅛"=1 Lb. (Indicator Scale 40).
Cut Off 0·8.
Max. 0·8 Cut Off.
Min. 0·44 Lbs. × 71,000
0·8 Cut Off.

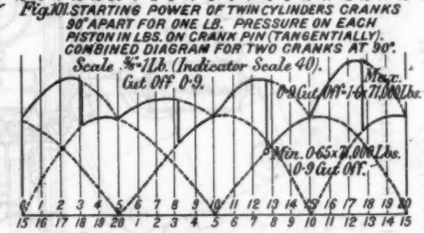


Fig.101. STARTING POWER OF TWIN CYLINDERS CRANKS 90° APART FOR ONE LB. PRESSURE ON EACH PISTON IN LBS. ON CRANK PIN (TANGENTIALLY). COMBINED DIAGRAM FOR TWO CRANKS AT 90°.
Scale ⅛"=1 Lb. (Indicator Scale 40).
Cut Off 0·9.
Max. 0·9 Cut Off 1·6 × 71,000 Lbs.
Min. 0·65 × 71,000 Lbs.
0·9 Cut Off.

starting torque for all cylinders for nine-tenths cut-off is 2,562,000 in.-lb., and for eight-tenths cut-off 2,121,000 in.-lb.

Figs. 107 to 110 give starting torque diagrams for the Homestake engine, the ordinates giving tangential forces on the crank-pin based on the combined indicator card shown in Fig. 112, with six-tenths cut-off, and 45 lb. receiver pressure. The final curve is shown in Fig. 107. Figs. 104 to 106 show the stages in the combination of the elementary running curves to develop the running torque curve for the Homestake engine, a combined running diagram being shown in Fig. 113.

The diagram, Fig. 111, gives the conditions of torque on the drum which have to be met, in winding or lowering. In this diagram the actual weight of the hanging rope, the load, and actual diameter of the reel at each point, are combined to give values, going up, ranging from 1,613,150 in.-lb. at the bottom to a maximum of 2,319,024 in.-lb., and then decreasing to 1,960,200 in.-lb. with the rope wound in and load at highest point. Going down, the load at the start is 7,000 lb., and the torque commencing at 693,000 in.-lb. rises to 1,465,693 in.-lb., and then decreases to 1,151,150 in.-lb. at the bottom. Fig. 102 shows the forces on the side rod at starting from different positions for the four-cylinder engine, with one reel declutched and the other starting the load from the bottom, when the worst condition for the side rod occurs when steam is admitted to the engine on the shaft of the unloaded clutch. This is the worst condition for starting, the forces to be contended with being given in Fig. 111.

The governor of the engine was adjusted so that when both clutches are in, and the hoist operated in balance, the cut-off occurred at 65 per cent. of the stroke, and the engine will start from any position with this

adjustment, as stated above. A depth indicator is provided for each reel, each indicator having two hands. One rotates with the reel, but the other only starts to move when the skip comes within 500 ft. of the surface. The indicators are worked from the reels through gearing.

A jet condenser is used in connection with this hoisting engine, this being of a counter-current type. The water enters the condenser through a spray pipe at the upper end, in which a reservoir of

Fig. 104. RUNNING TORQUE OF BOTH H.P. & L.P. CYLINDERS COMBINED, CUT OFF 0·6 OF STROKE. 45 LBS. REC. PR.

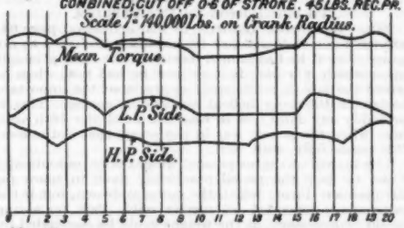
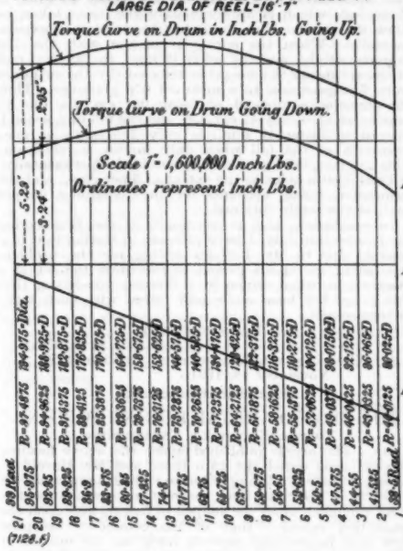


Fig. 111. DIAGRAM OF TORQUE CURVES OF WEIGHTS AND ROPE, EACH SPACE REPRESENTS 4-4 TURNS OF THE REEL. 88 TURNS IN ALL EQUALS 3,200 FEET OF ROPE. 5⅜ × 7¾ ROPE. 7 LBS. PER FOOT. SMALL DIA. OF REEL = 77" LARGE DIA. OF REEL = 16'·7"


Torque Curve on Drum in Inch Lbs. Going Up.
Torque Curve on Drum Going Down.
Scale 1" = 1,600,000 Inch Lbs.
Ordinates represent Inch Lbs.
5·29"
5·05"
5·24"

88 Heat.																					
21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
56·975	95·65	89·625	86·9	83·675	80·45	77·225	74·0	70·775	67·55	64·325	61·1	57·875	54·65	51·425	48·2	44·975	41·75	38·525	35·3	32·075	28·85
R = 97·4375	R = 94·9625	R = 91·4375	R = 89·4125	R = 85·3875	R = 83·3625	R = 80·3375	R = 76·3125	R = 73·2875	R = 70·2625	R = 67·2375	R = 64·2125	R = 61·1875	R = 58·1625	R = 55·1375	R = 52·1125	R = 49·0875	R = 46·0625	R = 43·0375	R = 40·0125	R = 37·0125	R = 34·0125
194·875 Dia.	189·925 D	182·875 D	178·825 D	170·775 D	164·725 D	158·675 D	153·625 D	146·575 D	140·525 D	134·475 D	128·425 D	122·375 D	116·325 D	110·275 D	104·225 D	98·175 D	92·125 D	86·075 D	80·025 D	74·0 D	68·0 D

(7128.F)

Fig. 105. RUNNING TORQUE CURVE OF H.P. CYLINDERS BOTH SIDES COMBINED. CUT OFF 0·6 OF STROKE.

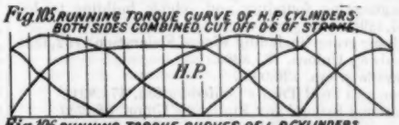


Fig. 106. RUNNING TORQUE CURVES OF L.P. CYLINDERS BOTH SIDES COMBINED. CUT OFF 0·6 OF STROKE.

Fig. 107. STARTING TORQUE OF BOTH H.P. & L.P. CYLINDERS COMBINED. 0·6 CUT OFF. 45 LBS. RECEIVER PRESSURE.

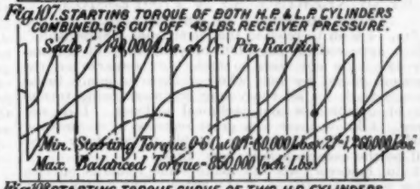

Scale 1" = 140,000 Lbs. on Cr. Pin Radius.
Min. Starting Torque 0·6 Cut Off = 60,000 Lbs. = 2" = 1,200,000 Lbs.
Max. Balanced Torque = 850,000 Inch Lbs.

Fig. 108. STARTING TORQUE CURVE OF TWO H.P. CYLINDERS COMBINED. CUT OFF 0·6 OF STROKE.

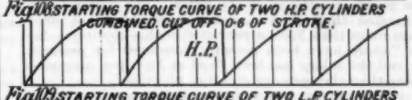
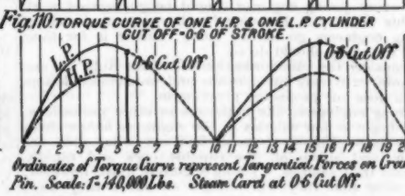


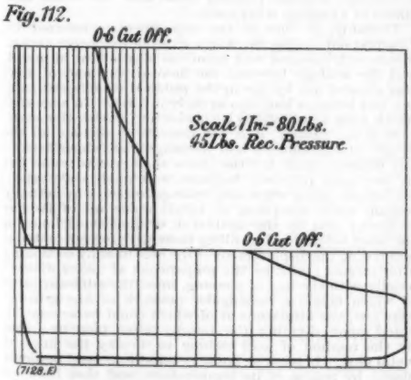
Fig. 109. STARTING TORQUE CURVE OF TWO L.P. CYLINDERS COMBINED. CUT OFF 0·6 OF STROKE.

Fig. 110. TORQUE CURVE OF ONE H.P. & ONE L.P. CYLINDER CUT OFF 0·6 OF STROKE.



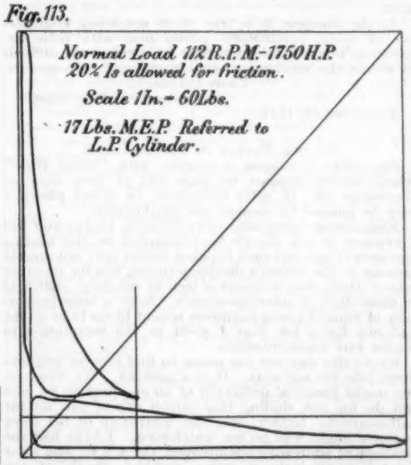
Ordinates of Torque Curve represent Tangential Forces on Crank Pin. Scale: 1" = 140,000 Lbs. Steam Card at 0·6 Cut Off.

Fig. 112.



(7128.E)

Fig. 113.



water is formed. Water from this reservoir falls through the condenser in three steps through three sets of spray plates with chimneys for air circulation. The air is extracted at the highest point of the condenser, while the water is extracted at the lowest point of the condenser. The exhaust steam enters the condenser at the hot end, or where the water is extracted. The air leaves the condenser practically at the temperature of the cooling water. The air is extracted from the condenser by an air-pump of the horizontal tandem type with 14-in. by 36-in. steam cylinder, and 22-in. air cylinder. The flywheel is 15 ft. in diameter.

The circulating pumps are two in number, single-acting, operated from the air pump engine by a rocker. The suction valves of the circulating pumps are located in the pump bucket, and the discharge valves directly above the bucket, the valves being of rubber of small diameter mounted in cages. The water from these pumps is elevated into a cooling tower. The discharge from the pumps passes through a vertical chamber. This discharge tank acts as a very effective air chamber. The water carries with it a certain amount of air which collects in this tank and fills the upper portion of it to a point considerably below the entrance of the water into the tank. The air is held in the chamber by the projection of the discharge pipe, which reaches nearly to the bottom of the chamber. At the bottom of this chamber is a row of 1-in. holes placed 9 in. above the bottom of the pipe. When the air reaches down to that point it escapes through the holes, the bubbles rising through the vertical discharge pipe and expanding as they rise. This type of air chamber produces a very quiet air pump, and air pumps of this class are employed discharging water through tanks of this design against heads of 40 ft. Water hammer is entirely eliminated with these tanks, as the water is discharged into an artificial atmosphere and there is no very considerable amount of water in motion between the tank and the pump. The air pump engine is of the Corliss type, the valve gear being controlled by a governor. The air cylinder is thoroughly water jacketed and is fitted with positively operated Corliss valves for inlet and discharge. There is a separate eccentric for the inlet and for the outlet valves of this air pump cylinder. The cylinder heads of the air pump cylinders are arranged to act as relief valves; the studs holding down the heads are made of extra length and springs are inserted between the nuts and the heads. If water enters the air pump cylinder it is discharged by the heads moving outward.

On account of the great storage of water in the condenser, which acts as a heat accumulator, the injection water can be adjusted to correspond with the average quantity of steam to be condensed. It is stated that when the hoist is started with full load there is hardly any perceptible change in the vacuum. A vacuum breaker is attached to the condenser to prevent flooding in case of any failure in the water pump. This vacuum-breaking device is actuated by a float set at the water line which has to be maintained in the condenser. In case of a rise of the water level a trip mechanism is actuated by the float which releases a weight attached to the vacuum breaker valve. This valve is a double-beat poppet valve made of bronze, having the area of a 7-in. opening.

INDUSTRIAL NOTES.

A CIRCULAR has recently been issued by the Electrical Trades Union, signed by Mr. J. W. Ball, general president, and Mr. J. Rowan, general secretary, stating that after most grave consideration the Executive have been compelled to suspend the London District Committee. This action has been taken because, among other reasons, the London District Committee have repeatedly instructed members to cease work without either consulting the members involved or obtaining the sanction of the Executive Committee; they have ordered strikes without making the slightest attempt at preparation; they have broken the rules by circularising branches time and again in defiance of the Executive Council, and have brought the union and its officials into discredit by publishing broadcast in *Electron* statements and insinuations, regardless of the rules prohibiting this. They have further laid bare to the employers—whom they specially enjoin to read the *Electron*—the internal business of the union; they have also destroyed the financial stability of the union by reckless expenditure. Had other district committees followed this example the union would have been broken long ago. Other grounds are that they have committed the members to affiliation with the Red International, despite the adverse vote of the branches, and have authorised the payment of strike committee fees far in excess of the rules, leaving members in other districts to fare as best they could.

Except from the utterly wrong impression it attempts to create in regard to the use to which capital is said to be put, the following statement—taken separately from its context—made by Mr. J. Hill, general secretary of the United Society of Boiler Makers and Iron and Steel Shipbuilders, in that society's report for November, is one of the most moderate we have yet seen from him: ". . . If, however, we collectively get the truth into our minds that the only thing of real value is work well done, and that capital is only the unconsumed portion of that work, then we, the workers, will place such a high value on our work that we will not permit anyone to keep back a part of the price of our labour and use that surplus in perpetuity to continue the exploitation. . ." We should like to call Mr. Hill's attention to the undoubted fact that boilermakers, and iron and steel shipbuilders, would have but little work at the present time, and his society would now be only of small account, had it not been for other equally real "workers" in the field, namely, those whose untiring efforts have led to the replacement of iron by steel of various grades, and to the accurate treatment of the newer metal. It is only following these, and following also those men who studied, designed and built the necessary instruments, machinery and plant, that manual labour has had an innings at all.

Mr. Finlay Gibson, the secretary of the South Wales Coalowners' Association, gave last week the following figures to explain the present high cost of domestic coal. The chief direct cause for the high prices now ruling is that the same rate of wages is being paid to each workman on an output at the rate of 205 million tons per annum, as was paid in 1913 for an output of 287 million tons. On every ton of coal supplied, either free of charge or at a nominal price, to the workmen there is a loss of about 18*s.* per ton. For the whole country this loss is estimated at over 400,000*l.* per month, or 5,000,000*l.* per annum, the whole of which has to be borne by the coal sold to the non-mining consumer. Every item of cost has increased, and in some cases to a greater extent than the increase in the

cost of labour; in consequence, coal used for colliery purposes now involves an additional expenditure of 10,000,000*l.* per annum. The cost of transport from pithead to port, factory, inland depot or house has also increased; dock authorities have largely added to their charges; the burden of local rates has increased by leaps and bounds. The following are some increases in cost per cent.: Pitwood, 79·2; other materials and stores, 235; local rates, 234; clerical and administrative staffs, 177; coal and power purchased, 147; repairs and renewals, 376. The only item in which there has recently been a reduction is in the percentage payable on the wage base rates. There is still an enormous increase in all standard wages and other production costs as compared with 1914. The principal cause of such increase is the decrease in the hours of working which have been reduced from eight to seven in the mining industry.

The result of the ballot taken by the London omnibus drivers and conductors on the companies' proposals introducing a "spread over" system of duty was announced last Saturday at the headquarters of the United Vehicle Workers. The figures were as follows: Against a strike, 5,144; for a strike, 4,095; majority against, 1,049. The number of men who voted was 80 per cent. of the total number entitled to vote. The system referred to allows of re-arranging the eight-hour day and coping with the rush hours; some of the men will stand off in the slack hours and complete their time duty later in the day. Further, an annual holiday of eight days, instead of six, with pay, will be given the men, and time and a-quarter for Sunday work instead of the ordinary rate. The present rates of pay are to be stabilised until April 1 next, then the wages will be subject to regulation by a sliding scale based on the cost of living.

From the engineer's standpoint, says *Mining and Metallurgy*, New York, labour organisations are of interest in so far as they affect efficiency, maximum production and unit cost, and in this respect the earlier labour organisations which existed in the age of the Guilds were ideal, inasmuch as they stood for competency of the apprentice and close co-operation between employers and employees.

Dealing with the collapse of the United States railway strike, *The Iron Age*, New York, states that many thousands of men had enrolled and would have taken the strikers' places. Forty-eight hours—and in many cases, twenty-four hours—proved sufficient for the mastery of many kinds of work. Some of the traditions concerning the "experience" required in several forms of service and some of the reasons given in justification of the higher wage schedules fastened upon the managements under Government control, were rudely shaken by the facility new men developed in preparatory try-outs. The experience was quite parallel with that of managers of certain tinplate mills when the Amalgamated Association some years ago staked its all on the issue of limitation of output, and lost. The union's monopoly of "experience" was counted on to win, but the mills were soon filled with young men fresh from the countryside, and they were never displaced. The British railway strike in September, 1919, also demonstrated that neither the railway workers nor the railways themselves were as indispensable to the life of the community as had been supposed. Further, skilled mechanics are becoming constantly less indispensable through the evolution of fool-proof machinery. The tendency is to bring machinery within the capacity of anyone possessed of average intelligence. One of the greatest services of the British strike of 1919 was in proving how competent the ordinary untrained individual can become in carrying out the duties of the so-called "skilled workers." That demonstration stands both as assurance to the public and as deterrent to workers who would lightly lay hold of the weapon of a strike against the people.

Depression in the Danish industries continues unabated, and the number of unemployed is on the increase. Even in old-established concerns the number of hands at work is, in some cases, only about 10 per cent. of the normal; others have closed down temporarily, and others again have ceased for good and are being wound up. Amongst the latter are several shipyards started with much flourish during the war which have now found it impossible to carry on; another firm involved is the Danish Cable Company, which tried to establish some sort of co-operation with an English company in the same branch of industry. The fate of other undertakings is in the balance; many old and well-established firms are in low water and are faced with very serious difficulties, although doing their utmost to avoid liquidation. Others are writing down their capital. Danish industries, apart from general depression, are feeling the effects of the German dumping competition. Some measure of temporary protection by means of an adjusted tariff has been urged, but the Government so far have been loth to deviate from their policy of non-intervention, fearing counter moves by other countries to the detriment of the export of Danish agricultural produce.

The General Council of the Trade Unions Congress gives the following figures for the amounts paid by the principal unions in unemployment benefits during the year ending September 30:—

Engineering, founding, and vehicle building trades, 2,257,189*l.*
Mining group (including Miners' Federation), 792,839*l.*
Railway Unions, 735,898*l.*
Textile group, 736,088*l.*
Iron and Steel Trades Confederation, 474,891*l.*
National Sailors' and Firemen's Union, 48,252*l.*
General Workers, 520,239*l.*
Workers' Union, 246,850*l.*
Enginemen, Firemen, and Mechanics, 106,116*l.*
Foundry Workers, 138,710*l.*
Boot and Shoe Operatives, 123,872*l.*
London Society of Compositors, 67,615*l.*

"ENGINEERING AS A PROFESSION."

To the Editor of Engineering.

Sir,—I wish to refer to the letter from "Slide Rule" which appeared on page 692 of your issue of November 18. I do not wish to make any remarks on the question raised by him whether there is going to be enough work for all the young engineers being turned out of universities and technical colleges. I do not know. I know there is a great scarcity of engineering work at present, but I am unable to prophesy what will be the case in a few years' time.

I do, however, wish to make some remarks on two other points mentioned in the letter. The writer seems to imagine that all young engineers should at once obtain more than 350*l.* a year *and* in this country. He says "there have been recently vacancies for research men and the salary has been fixed at 350*l.* per annum—far less than the earnings of a dud plumber."

I do not express any opinion on the earnings of the plumber, but it seems to me that 350*l.* per annum is not a bad salary for a young engineer.

The writer states "generally neither the parents nor the boy know what is required of the engineer to-day or that it may be imperative to go abroad in order to command a reasonable salary." Does the writer imagine that every young engineer should be guaranteed work in this country? Fortunately the great majority of young engineers go abroad freely, and it is for their good that they should do so.

I consider the communication of "Slide Rule" is one of those extremely mischievous and unbalanced letters which does our profession great harm.

Young engineers, like beginners in other professions, must begin at low salaries as the engineers before them have done. Employers soon find out what men are worth, and shove on the capable ones and rapidly increase their salaries. Young engineers must, however, remember that they will not get on unless they work hard.

At the moment it is true there are many engineers out of work, particularly young men with little experience, but at the same time it is extremely difficult to obtain the services of capable experienced engineers.

Yours faithfully,
"An Old Engineer."

November 29, 1921.

To the Editor of Engineering.

Sir,—May I express sympathy with "Slide Rule" whose lament appears on page 692 of your issue of November 18. If, after Christmas, he is not placed I may be pleased to consider his employment.

Engineering enters into every industry to-day and will I venture to say shortly be recognised as the leading profession; how sad such hopeless letters are; not merely because of the author's disappointment, but for no other reason than that it shows a lack of self-help—self-help in these days of interdependence. Such a large proportion of trained young engineers appear to me to be on the look-out for a job that I yield to the temptation to tender this communication.

We in this day are too prone to find regular employment jobs for our sons. It is a mistake. We overlook the useful practical definition of an engineer as he who can do for one shilling that which others can do for half-a-crown; further, Sir, the derivation of the word engineer might well be our watchword. I have had the privilege of addressing unemployed, the A.S.E., and some revolutionarily-inclined men; frankly, much of the discontent is due to want of self-help, too much dependence on some one, an employer, a Government, or a municipality finding jobs for them. It may not be orthodox, but I believe the workshop in the back yard contributed in no small measure to the industrial initial supremacy of this country. I have appealed with success to the workmen to start making something in the back yard or in the home after the short day's work is done. I know of one at least in receipt, through such enterprise, of well over 1,000*l.* a year in royalties. The greater the costs—the relative costs—of production in this country, the greater is the scope of the engineer. The higher the labour costs the greater the demand for newer machinery in production, to say nothing of the room for new products.

As to civil engineering, roads and railways alone are wanted to open up the point nine of land in this Old World, to say nothing of the American Continents. Engineers must employ business men, and they must not be so ready to condemn fellow engineers' work.

Yours, &c.,
A. E. Parnacott, M.I.Ae.E.

Penge-lane, Penge, S.E.,
November 22, 1921.

"PILE-SET GAUGES."

To the Editor of Engineering.

Sir,—Mr. Ernest Latham, in his article on page 684 of your issue of November 18, has kindly referred to my gauge, but as he has named inertia as the chief principle upon which it works, it is evident he had not, when he wrote the article, sufficiently appreciated the important action of the long helical suspension spring. This is probably my fault, as it was not until the 16th inst. (*i.e.*, when the article was in the press) that I discussed this point fully with him.

The inertia of the suspended weight does undoubtedly assist to keep the pencil practically fixed in space for the moment during which the curve is drawn, but if the instrument depended on inertia only, then no spring would be necessary, as the weight could be suspended by a flexible cord, then when the monkey struck the pile this cord would become slack, and the weight would be free to fall under the action of gravity. It is found from the equation $s = \frac{1}{2} g t^2$ that it would fall 49 mm. in $\frac{1}{70}$ second, which is approximately the time taken to draw the curve. This result has been obtained experimentally. When the spring is in use with the 710 gramme weight, and the set is 19 mm., the upward pull of the spring on the weight is reduced (by the set) only from 710 grammes, to a mean of 676 grammes. Thus the acceleration instead of being 981 cm. s.s. due to gravity alone is only 47 cm. s.s., and the fall in $\frac{1}{70}$ second, instead of being 49 mm., is only 2·5 mm., or one-twentieth of the fall when only inertia is relied on. This 2·5 mm. fall has also been obtained experimentally.

Thus inertia helps to the extent of 5 per cent., and the suspension spring accounts for the remaining 95 per cent. of the result obtained.

In conclusion, and as mentioned at the Engineering Conference last July, I have pleasure in stating that it is entirely due to Mr. Latham setting me the problem (by telling me of his gauge) of recording the set of a marine pile, when driven by a floating pile-driver, that this gauge has been made and tested with such satisfactory results.

Yours very truly,
A. S. E. Ackermann.

17, Victoria-street, Westminster, London, S.W. 1,
November 29, 1921.

"THE FLOW OF METAL DURING FORGING."

To the Editor of Engineering.

Sir,—The article published under the above heading in your issue dated the 18th inst., and Mr. Harold F. Massey's letter relating thereto which appeared on page 728 of your last issue, prompt me again to proffer some comment upon the subject of forging and upon the contention raised—"that of the commonly accepted view that hammering expends itself on the outside of a forging, whereas pressing penetrates the whole substance of a forging, is erroneous."

Probably, as one of the experimenters referred to, I carried out during the war a series of extensive experiments with coloured wax upon the plastic flow of metal, and the analogy between the flow of wax and of steel was pointed out by me in the publication referred to in my last letter as long ago as early in 1919. In a treatise which aims at supplying a concise and practical conception of the subject, it is not possible to include all the details of experiments and investigations which lead to any definite result, but the above analogy was tested out by me upon full-sized forgings, and upon scale reproductions in many ways, and amongst others—by actually forging shells composed of billets made up of lamilar sections; and by the method of drilling small holes in the billet before forging, filling these with foreign material and noting the displacement of the hole lines by sectioning after forging; also by the preparation of billets divided axially with the line of piercing, upon the adjacent faces of which billets a rectangular network of line grooves were cut, the displacement of which could be accurately noted upon dividing the forging after piercing; also by the method of acid etching to display the lines of metal flow. It must be borne in mind that steel becomes plastic by reason of its temperature, and that between certain temperatures there is a transition stage between rigidity and plasticity; by the temperature of plasticity is meant that point at which the metal will flow by deformation without mechanical injury to the material. Perhaps one of the most important considerations which affect the plastic stream line flow of hot steel is that of *temperature zones*, by which is meant non-uniformity, not necessarily of heating, but in the temperature of the metal at the instant of deformation and during plastic flow. My experiments with wax and steel made it perfectly clear that those parts of the billets which were chilled by contact with the die or punch greatly modified the lines of flow of the material, so that in order to investigate uniform conditions many of the wax experiments had to be carried out submerged in a water bath maintained at a constant temperature for each experiment. The phenomena referred to sometimes experienced during shell forging, when a loose cone-shaped piece of metal appears to be carried into the shell ahead

of the punch, is the result of the cooling action of the punch tip upon the metal immediately in contact with it, which results in a sufficient *increase* of *rigidity* of the metal as to cause it to *shear* rather than *flow* at the particular section of rupture. This is usually the outcome of over-cooling the punch and of allowing it to rest upon the billet unduly, before piercing. The cone and prismatic formations are familiar commonplaces when testing many materials to destruction by crushing. The triangular prisms of wax resulting from the dynamic blow upon Mr. Massey's 2¼ in. by 1 in. wide bar, would appear to be formed due to: (*a*) The wax being unduly cooled in the region of the blow by contact with the pallets; (*b*) the temperature of the wax being below that necessary for *plasticity*. Unless the experiment was performed with uniformly heated wax and pallets, maintained so by immersion in a liquid bath, then the results must be ambiguous. Coming now to the penetrative effect, so little is the internal structure of the material affected as the *rapidity* of the blow is increased, that a *wax candle* may be fired clean through a wood board, with little more deformation than the rounding of the end which strikes first. The analogy for steel in this experiment is that of the armour-piercing shell, which may be made to pass through a hardened steel plate equal in thickness to the diameter of the shell, without more damage to the shell than the slightest rounding of the extreme sharp point. Plastic displacement is caused by propagation of stress from particle to particle, the stress causing molecular mobility is necessarily first experienced at the point of application, and as time is required to propagate stress, it follows that if the blow is only *rapid enough*, deformation may have taken place and the blow have been expended *before* remote parts of the billet have even received news of the onslaught. It is surprising that any contention should have arisen to dispute that hammering *does* largely expend itself upon the surface and regions near the surface of the metal. So many instances arise in daily life as to make this fact almost obvious, instance the hammered end of a cold chisel or set; the formation of a rivet head upon the end of a hot or cold rod; the surface disruption of the head of a mallet, or old sledge hammer, &c., &c. "*The instinctive feeling that it is better to squeeze plastic metal into shape than to form it by hitting the external surface*" is one that has long ago been amply confirmed in theory and practice, especially in the production of large gun forgings and important work of a like nature, when the survival of the fittest method has displaced the steam hammer. The function of the drop stamp is essentially the *rapid* deformation of *thin* and intricate surface projections requiring a sharply-defined outline which would otherwise be too rapidly cooled below the practical plastic range when treated by the comparatively slow deformation under the hydraulic press; and in some instances by the facility with which an *intensity* of deformation pressure results from a small displacement.

Yours faithfully,
CLIFFORD O. BOWER.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to Mr. Massey's letter in your last issue, may I point out that the difference of opinion there indicated raises a question of considerable interest. I agree with your editorial comment on the importance of time in effects of this kind, and give instances. In driving piles, a heavy tup with but small drop will be more effective, as I have myself observed, than a light tup of greater fall, though the kinetic energy of each may be the same. In one case the pile point is driven downwards as the principal effect, in the other, the pile top may be damaged with but little penetration. I have seen a semi-skilled labourer, who, appreciating the time element, though not perhaps understanding it as such, use an extremely small chisel, with broad cutting edge, and with a heavy slow-moving hammer, taking a "cut" in mild steel, which would have been quite impossible had the chisel been heavy and the hammer light and quick moving. Again, in drilling granite by pneumatic hammer, the hammer block being light and the movement quick, although great progress in drilling is made by the great number of blows per minute, yet when compared with good hand drilling, in which a heavy slow-moving hammer is used, the amount of granite displaced per blow is in the first case much smaller, and the power applied per inch drilled much greater than in the second case.

When the Charing Cross roof fell some years since it was observed that the partial destruction of the west wall, due to unbalanced thrust of the arch rib, took about 12 minutes—to bulge, crack and overturn. Here time was manifestly an important condition of failure.

The flow of glacier ice, and the distortion through long ages of geological strata are instances of very slow internal movements.

Effects with which we are familiar may seem to be better understood than is really the case. The rate of rupture of pieces under test may, by being usual, not strike us as of great importance, and indeed may not be of importance within the limits of common observation—though "nursing" a piece for good elongation is not unknown—but when we are dealing with matters outside this range, our limited experience may be of little use in forecasting results. I think, however, that we may infer from what is known, that the slow impulsive blow would be more effective in ensuring flow of metal throughout the mass, than a quicker blow more effective in the surface moulding of a piece. The particular care of moulding the *hot* piece is, however, duplicated by duration of contact where this is considerable, of the hot metal with the cold die.

It would appear—the whole question being very involved—that a serious research into the effects of time on mechanical operations would be of great value. Impact tests are at present very confusing, and but little understood for want, as I suggest, of this sort of knowledge.

Yours truly,
W. H. THORPE.

12, Buckingham-street, Strand, London, W.C. 2,
November 29, 1921.

TO THE EDITOR OF ENGINEERING.

SIR,—The mechanism of the flow of metal during forging is well shown by Mr. Massey's experiments with wax, though in some cases the flow diagram can be constructed from the external appearance of the forged piece. The breaking down of the material diagonally, or in wedge formation, is just what takes place in the testing to destruction of many engineers' materials, and it is useful to see this brought out so clearly in the case of deformed hot metal.

Where the experiments fall short is in ignoring the time factor, as you, Sir, point out very clearly, and, no doubt also the mass or inertia of the forging and anvil block in relation to the mass and energy of the hammer. When pressing, we know definitely what external force is applied to the forging, and can control the time of contact. In hammering, neither of these is known with any approach to certainty, and the phenomenon is complicated. Generalisations from small-scale experiments in one or two shapes must therefore be taken with reserve.

That hammering can produce surface effects and fail to penetrate the mass, is common knowledge among mechanics, who know by experience the results obtainable by using either a light or a heavy hammer depending on circumstances. In cold riveting, heavy sledge-hammers are used with a very deliberate action to get a good "upset." Lighter hammering would simply burr over the end of the rivet. In "setting" a bent bar in the lathe, a turner will first reverse its curvature, using pressure, and then by hammering on the previously concave side, stretch the surface, thereby securing the "set." Hollowness produced by excessive hammering or pressing of a round bar forging may be explained by the stretching of the metal at and near the surface by blows or pressure which fail to penetrate, due to their localisation and the resistance to displacement of the metal in the mass of the forging out of direct reach of the effort. One is reminded of the workshop dodge of easing a tight nut on a screwed bolt by placing the nut, fast on its bolt, in a block of metal serving as an anvil, and hammering in the flats. The uninitiated might suppose that the result would be to close the nut still more tightly in the bolt; but the effect, one may suggest, is that the nut is expanded due to the stretching of the surface metal.

Yours truly,
W. H. SNOW.

1, New Quay Street, Manchester.
November 30, 1921.

TO THE EDITOR OF ENGINEERING.

SIR,—I venture to think that the editorial note attached to Mr. Massey's letter in your current issue does not deal quite adequately with the question. What you say about pitch and sealing wax is perfectly true *for pitch or sealing wax* which, in their ordinary condition, are very brittle substances, though as is well known they will flow under pressure if given sufficient time. The nature of red hot steel is very different from pitch or sealing wax, and to conclude from the assumed analogy that it will behave in the same way as pitch or sealing wax is not, in my opinion, justifiable.

If a piece of sealing wax is struck with a hammer it will, as you say, break, but in the same circumstances whatever happens to red hot steel it will in general certainly not break. I do not include here high carbon overheated tool steel. I may say I have found from experiment that ordinary plasticine simulates, under the same treatment, the behaviour of red hot steel with great fidelity.

These observations bring me to your original discussion of Mr. Massey's paper in your issue of the 18th inst., and to your remarks in connection with shell forging. The difficulty to which you refer, namely, the formation of a loose cone of metal at the base of a shell, which frequently came away on machining, was brought to my notice during the war and I at first suggested the obvious explanation given by you. But this happened to be one of those not infrequent cases where the explanation was too obvious to be true. It is, as a matter of fact, not true, and experience has taught me that a very obvious explanation is usually to be distrusted.

From experiments with a model shell press which I made, and using plasticine billets built up of various colours, I was able to reproduce exactly the production of a separate cone in the base. The occurrence of this cone is due to piping in the billet, and I was successful in reproducing the observed effect in the following way:—

I built up a number of billets of plasticine, each consisting of three different coloured cylindrical pieces pressed together so as to form one large cylindrical billet of the same diameter. In each case the top portion was of white plasticine. In the centre of the middle piece I simulated piping which is a line or strip of discontinuity, by embedding there two narrow strips of very thin paper side by side, and different billets had strips of different lengths to imitate a greater or less degree of piping. On pressing out the shell with a flat-ended punch a cone of perfectly clean white plasticine from the top of the billet was found in the base on sectioning, the size of the cone *varying with the length of the paper strips*.

The nature of the flow is such that no cone of material is carried in front of the punch. The material, in fact, at the face of the punch flows out radially and at right angles to the direction of motion of the punch. This was shown very well in one case where on taking out the model shell one of the pieces of paper was found approximately at its original level, but adhering to the outer wall of the shell.

You may possibly not be aware that if a coloured centre is put in a plasticine billet and pressed out as above the punch will pass through that centre piece, and on sectioning the centre piece will appear as an annulus of coloured material running round the wall of the shell. I may say that this has actually been shown by a friend of mine to be so in the case of a piece of copper embedded in the centre of a steel billet, and on pressing and sectioning the copper appeared as an annulus through which the punch had passed.

As a matter of general interest I may add that a valuable method of investigation of the flow of metals in the cold state which may be new to you is to make up a blank of thin laminæ of copper or other metal and then press it to the required shape; it can then be taken to pieces and examined with the most instructive results. This method is due, I believe, to Sir Edward Rigg, of the Royal Mint, who once very kindly showed me a wonderfully interesting experimental specimen of a medal struck in this way.

Your obedient servant,
A. DOBREE.

104, Victoria-street, Westminster, S.W. 1,
November 29, 1921.

[Mr. Dobrée's experiments, as described, appear to confirm our statement that the cone in the base of a shell is formed of metal pushed down in front of the punch from the upper end of the billet. It is reasonable to suppose that if piping exists, the cone may be larger and more perfect on account of its easier passage, but that the real cause of its existence is due to the action of the punch and not to any piping which may be present, is, we think, proved beyond question. Our views are based on a large experience of heavy shell forging, and they are confirmed not only by very exhaustive experiments conducted by the Government early in the war but by many independent workers. Figs. 28 and 29 of Mr. Massey's paper show the cone-formation in plasticine shell-models in which there is no question of piping, and indeed the definite prism-formation obtained when bars of laminated wax are struck (as in Fig. 23) is only another aspect of the same phenomenon.—ED. E.]

BRITISH TRADE HANDICAPS IN CHINA.

TO THE EDITOR OF ENGINEERING.

SIR,—At a time when many British engineers find difficulty in obtaining orders, it might not be out of place to consider what means, if any, could be devised to put our foreign export trade on a par with our competitors here in China, in at least some respects, which so far as are apparent, have not been considered by those who govern us. Last summer an American house got an order and delivered to the Canton Government a very considerable quantity of machine tools and arsenal plant generally, as well as aeroplanes. This last week a contract valued at 8,000,000 dols. (Peking), say, at the present exchange 1,000,360*l*., for arsenal plant and machine tools has been signed with the Peking Government by the representative of a Danish engineering group for General Chang Si Lin. In each case a British firm had the contracts offered them, but could do no business because the Foreign Office does not permit British firms to entertain business of this description.

If the same law applied to all, no one could have any objection to the Foreign Office ruling, but the matter surely is worthy of the attention of British engineering manufacturers where, as in the present case, and as in the same case before the war, British firms alone in all China are penalised by treaties entered into by the powers to control their nationals, and adhered to in fact only by the British Government to the immense advantage of German, Japanese, American and other firms, and to our great disadvantage.

Foreign Office policy has a far greater bearing on British trade than the majority of people at home give consideration to. In Hong Kong especially, the situation regarding our overseas trade is becoming acute, as the Hong Kong Government refuses to recognise the Southern Government of China, with a result that American and German manufacturers' representatives, who apparently are bound by no such trade disabilities politically inflicted upon them as our nationals, are taking away and, indeed, have taken away, a very considerable portion of our engineering trade; first, by reason that we are not permitted to sell any goods that might conceivably be used in the manufacture of arms, and secondly, by reason of the abolition of extra-territorial right in respect to the Germans which permits German nationals to trade freely anywhere in China. The law refusing German rights of domicile in Hong Kong is probably the most futile and ill-considered ordinance yet devised to protect our trade, as before the war German merchant houses were far greater distributors of British goods than the British merchant houses were, and the same is true to-day. Once let the Chinese and Germans in Canton and Kuangtung generally, open up the port of Whampoa for foreign trading vessels and Hong Kong will find itself cut off from its main hinterland and degenerate into merely a calling station for liners. All interested in the sale of engineering goods might well consider and devise means for the enhancement rather than the curtailment of their narrowed market, and only by taking an intelligent interest in certain aspects of foreign politics can this be done to any great extent.

Thanking you, Sir, I am, yours faithfully,
MOORE BENNETT.

83, Chao Yung Men, Peking, October 25, 1921.

"APOLLO" 2¾-IN. HOLLOW SPINDLE TURRET LATHE.

CONSTRUCTED BY MESSRS. POLLOCK AND MACNAB (1919), LIMITED, ENGINEERS, BREDBURY.

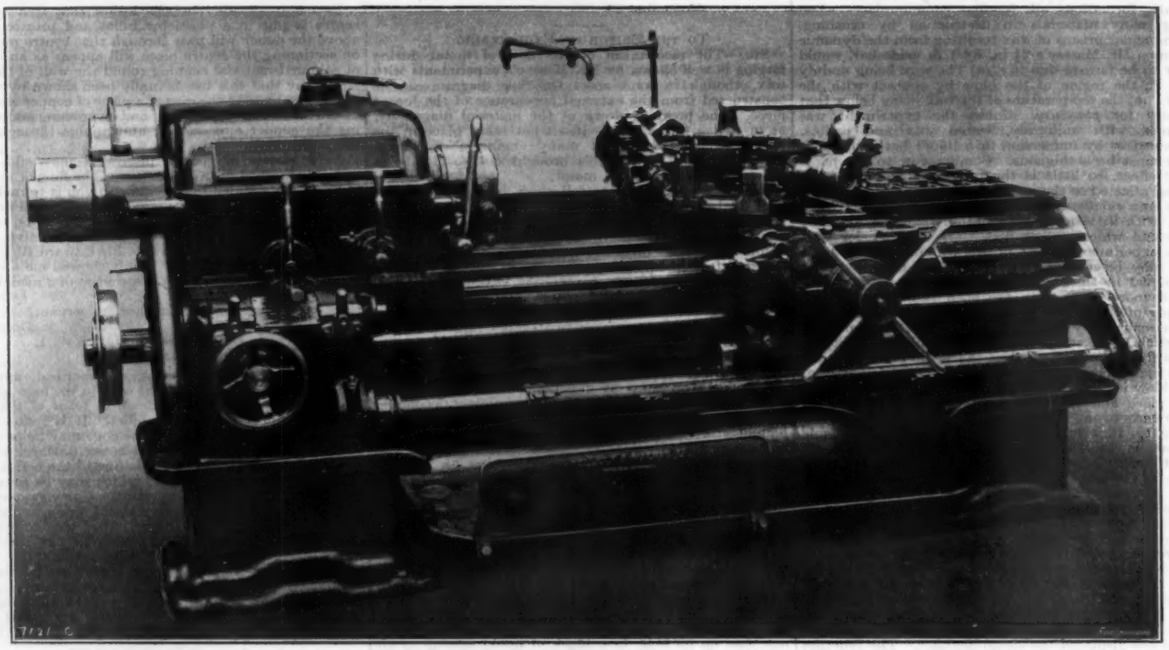


Fig. 1.

The figure above and those on Plate XLII show a new model of hollow spindle or bar lathe recently brought out by Messrs. Pollock and Macnab (1919), Limited, of Bredbury, near Stockport. This machine has a hollow spindle, 3¼ in. in internal diameter, intended for work 2¾ in. in diameter and up to 36 in. in length. The height of centres is 9½ in. and the length of the bed 8 ft. 9 in.

A general view of the lathe is given in Fig. 1, on this page, while in Figs. 2, 3 and 4, on Plate XLII, are given drawings showing the elevation, plan and end elevation of the machine, Figs. 5 and 6 illustrating the bar steady and the tray for tools, collets, &c., used in connection with it. In Figs. 7 to 29 we give various details of this machine tool, as for instance the headstock and speed box which is shown in Figs. 7 to 10. Details of the headstock gears and clutches are illustrated in Figs. 11 and 12. Figs. 13 to 15 show the arrangement of the feed-box, while the remaining illustrations refer to the slide, Figs. 16 to 19 showing the apron, Figs. 20 to 25 the turret and slide itself, and Figs. 26 to 29 details of some of the movements.

Starting, stopping and reverse are controlled by an horizontal lever to be seen extending over the headstock from the back towards the front of the machine, in Figs. 1 to 4, and also in the Figs. 8 and 10. By means of a sliding collar on the hollow spindle *c*, Figs. 10, 11, &c., this lever moves, to the right or left, a rod extending down the centre of the spindle *c*, and by means of small rollers and wedge contacts causes one or other of the clutches *d* and *e*, shown in Fig. 11, to engage, the former being direct gear and the latter the reverse. Fig. 12 shows a detail of these expanding clutches. The eight spindle speeds are obtained by means of the two shorter levers, in front of the headstock, the longer one, as will be clear from the general view, Fig. 1, &c., operating the chuck. Of these two change-speed levers, one *g*, Fig. 7, gives a main change for fast or slow, while the other *f* is a selector lever giving one of four changes in connection with either the fast or slow gears engaged by the lever *g*.

The lever *f* has two movements. It may be moved in and out, and also sideways. If it be moved in, one or other of two clutches on the shaft *b* is engaged, giving one of two speeds; if it be pulled out, one or the other of two clutches on the shaft *a* is engaged. This arrangement may be followed in Fig. 10, while the clutches and gears engaged are shown developed in Fig. 11. With a speed for the single pulley of 500 r.p.m. the spindle speeds are 300, 190, 120, 72, 52, 32, 21 and 12 r.p.m. The first four are obtained with the lever *g* over to the left, and the last four with it over to the right. The two higher of each group are secured with the lever *f* pushed in, and the two lower with it pulled out. All speed changes are interlocked. The starting lever operates on the pulley spindle, and, therefore, on all speeds. The three spindles *a*, *b* and *c* run in ball bearings, the main spindle running in phosphor bronze plain bearings. The driving pulley also runs on ball bearings, and a ball thrust bearing is provided for the main spindle, as shown in Fig. 7. The diameter of the pulley is 10 in., and it takes a 4-in. belt.

The chuck lever has already been referred to. It operates the chuck by means of toggles, and the collets may be opened or closed while the spindle is running. The split collets are in four sections. The chuck is locked in position on the spindle by a combined clutch and locking ring, which, while enabling it to be quickly attached or removed, prevents it from tightening up or slackening off while at work. The machine is fitted with automatic roller bar feed, operated by a friction clutch controlled by the chuck lever, and only able to come into play when the chuck is opened. With this arrangement the bar is fed forward and comes in contact with the stop without shock. The chuck can be opened without the feed being engaged.

The feed-box is gear driven from the main spindle. It is illustrated in Figs. 13 to 15, Plate XLII. The drive is totally enclosed. Eight feeds are provided by this box, in either direction. Four changes are secured by means of gears on the first spindle. These are engaged by sliding clutches operated by the hand wheel in front of the box. This wheel turns a ring cam which moves two levers in the box, each lever controlling one clutch, which can be placed in one of two positions engaging gears, or in neutral. Working in conjunction with the cam lever clutches is a clutch operated by the short vertical lever shown above the hand wheel (Fig. 14). This gives two other changes for each of the four main changes, or eight in all. Change of direction is secured by the second vertical lever towards the right hand upper corner of the box, which also works a clutch, and a reversing train of gears. All three shafts in the box are mounted in ball bearings. The feed-box is arranged as an oil bath.

In addition to the changes in the feed-box, a small lever on the slide apron, shown in Figs. 16, 17 and 19, enables two more main variations to be utilised. This lever actuates a small sliding clutch on the feed shaft, as shown at the back of the apron in Fig. 19. This clutch engages one or the other of two small gears which in turn mesh with corresponding gears on a short intermediate spindle in the apron, seen in Fig. 17. This spindle carries a worm which drives the gears moving the apron and slide. The worm spindle is fitted with a ball thrust bearing. The apron has double walls and the gearing is of steel. The slide is tripped automatically by stops on a splined bar to be seen in front of the lathe extending the length of the shears below the apron. The necessary automatic rotation of this bar to correspond with each change of face of the turret is effected by a shaft driven by gears from the turret and driving the stop bar by means of a chain enclosed in the guard shown at the right hand of the machine in Figs. 1, 2 and 3. The adjustable stops on this bar engage with lugs on a trip bar in the bottom of the apron, and shown in Figs. 16 and 17. The trip arrangement consists of a small cradle which, when the trip operates, is pressed down by a spring plunger, so that the driving worm is clear of the apron worm wheels.

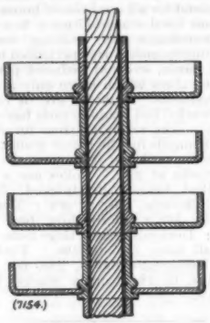
The back casing or apron illustrated in Figs. 26 to 29 provides two movements derived from the back shaft which is cut with a right and left-hand screw of 3-in. pitch. One of these movements is the quick power traverse for the slide, in either direction. It is obtained by means of the two cone clutches (Fig. 27) operated by a short radial rack on the end of a lever at the upper end of which is another segment of rack in gear with a pinion on the end of a spindle running to the front of the slide. At the front end of this spindle (Fig. 21) is a horizontal handle which, when lifted, engages the clutch for quick power traverse in one direction, and when lowered engages the clutch for the other direction, as will be clear from Fig. 27. Keyed to the pin on which the rack lever operating the clutches is pivoted, is a rocker fitted with rollers. When at the limit of the possible traverse these rollers come in contact with stops, the rocker is depressed and the clutch automatically thrown out. The quick traverse lever (Fig. 21) is engaged with the pilot lever, and automatically disconnects the latter when either clutch is thrown in, so that this lever does not rotate. On disengaging the quick traverse clutch, the pilot lever is again automatically connected to its spindle.

Turret details are given in Figs. 20 to 29. The width of the turret across the flats is 14 in. It will carry six tools, each face being 8 in. by 5 in., and with a hole 3½ in. in diameter. Of the illustrations, Fig. 21 gives a drawing of the turret and slide from the operator's side, while Fig. 23 is a plan. An elevation from the chuck end is given in Fig. 20, and the reverse end is shown in Fig. 24. The turret may be rotated either by hand or by automatic motion. The lever which withdraws the indexing plunger also operates the turret clamping ring, and controls the clutch for rotating by power. After the turret has been unclamped the operating lever is depressed and the

indexing finger is withdrawn. The turret may then be rotated by hand. If it is desired to rotate the turret by power a further depression of the lever releases a catch which enables a spring-operated clutch at the back of the slide, shown in Figs. 23 and 24, and in detail in Fig. 29, to engage. This couples up the second motion of the back apron (shown in Fig. 28, and the left hand portion of Fig. 27) through gears to a cross spindle in the slide, to which is attached a bevel driving the turret (Fig. 23). The turret can thus be rotated to the desired station. The pilot lever shaft is provided with adjustable fingers for repeating lengths and depths. A plan of the clamping ring below the turret is shown in Fig. 22, and the manner in which this is operated is indicated in Fig. 20 the ball knob of the clamping lever working in a slot in a sliding rod.

THE "HYDROHOIST."

AN interesting variation of the popular endless rope pump has just been brought out by the Crawley Agrimotor Company, Limited, of the Tower Works, Mandeville-road, Saffron Walden. In this pump an endless flexible wire rope is used, with, threaded on it, a series of small pressed steel cups. A section of the rope is represented in the accompanying figure. The rope is galvanised, and the buckets are similarly protected. Each bucket or cup is made in the press, and is fitted in the centre with a pressed thimble which acts as a spacing piece, and through which the flexible rope is threaded. The standard size of the cups is 1¼ in. in diameter, and the rope works over pulleys 14 in. in diameter. As in the well-known arrangement the rope passes over a driving pulley at the top of the well, and at the lower end holds in



the bight a double-rimmed pulley without a spindle, running free. The top pulley is enclosed in a casing which collects the water thrown off.

The Crawley Agrimotor Company inform us that with an immersion of 3 ft., and the rope running at a speed of 600 ft. per minute, the delivery is 3,500 gallons per hour. This is considerably more than represents a solid column of water of the diameter of the pump cups or buckets. The string of buckets rises completely filled with water, and in addition a large quantity is carried upon the outside. As the action of pumps on these lines is well known we need not go into details on these points. Neither need we, in placing this pump before our readers, enlarge to any extent upon the simplicity of installation and other points which are already well known to engineers, and to whom this type of machine is now familiar. The handiness of the pump, which requires no fixture beyond the casing at the well-head, is self-evident, and will appeal to tenants on account of ease of fixing and dismantling.

The pump can be worked by hand on lifts as high as 150 ft. Small power installations can easily be arranged, and if larger capacity is required this can be secured by running two or more ropes alongside each other.

ACCIDENTS IN THE STEEL INDUSTRY.—The total steel mill accident rate, per 10,000,000 hours worked, has fallen in America 55 per cent. since 1907, and the fatal accident rate has fallen more than 70 per cent., as shown by figures of the Department of Labour. The figures given for 1907, per 10,000,000 hours worked, show 7 deaths, 13 cases of permanent disability, 788 cases of temporary disability and a total of 808 cases. For 1920 these figures were 2 deaths, 9 permanent disability, 357 temporary disability and 368 cases in all. Severity rates fell in about the same proportion as frequency rates. Figures for 1907 showed an average of 72 days lost for each 10,000 hours of exposure. In 1920 the loss was only 27 days. All departments, save the electrical, shared in this gain, the open-hearth and blast-furnace plants showing the greatest decreases, and needing to do so, for their rates in 1907 were more than double the average of the other departments, according to *The Iron Age*, of New York.

THE BEARDMORE QUICK-ACTING FULL-WAY VALVE.

A QUICK-ACTING full-way valve designed to occupy a very short length is illustrated in Figs. 1 and 2 herewith. This Beardmore valve is manufactured by the Dowson and Mason Gas Plant Company, Limited, 3, Manchester-street, W. 1., and is so designed that a 3-in. valve occupies only a length of 4 in., including

Fig. 1.

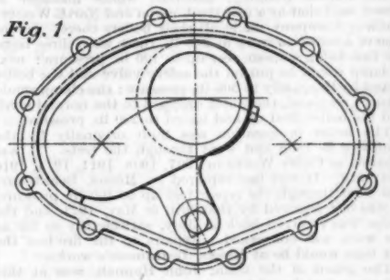
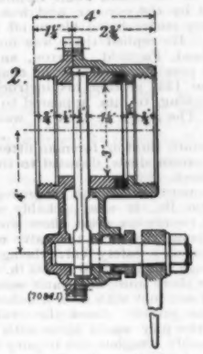


Fig. 2.



screwed socket ends to take the pipe. It is intended for liquids of all kinds, water, oil, &c., but is not designed as a steam valve.

Our drawings are practically self-explanatory, the gate being swung through a sector of a circle inside a casing which is of cast-iron. The gate is backed by a pressure ring of gun-metal fitted with springs to keep it up to its face. The spindle is provided with a stuffing-box, and the valve is operated by means of a straight handle. It is very easy to work, and its action more prompt than is possible with any screw-operated valve.

EIGHT-TON MOTOR ROAD ROLLER.

THE illustrations which are given on page 762 show the interesting motor road roller which was exhibited by Messrs. Ruston and Hornsby, Limited, of Lincoln, at the Public Works, Roads and Transport Exhibition at the Agricultural Hall last week. Rollers of the motor type appear to be coming more generally into favour, particularly for service abroad, and in view of their very extensive connection with machinery of this class it is matter for no surprise that Messrs. Ruston should have turned their attention to rollers of this type. Long experience with steam rollers is no bad apprenticeship for the building of motor rollers, and one may certainly expect that the Ruston motor roller will take an important place in the market. The general appearance of the machine is well shown in Fig. 1. As will be obvious, it is of the three-wheel class. This build of machine permits the use of a larger diameter of driving wheel than is possible with the tandem type, giving a greater grip and enabling the roller to work on steeper hills. A shorter wheel-base is also possible, while the greater rolling width gives greater stability on rough ground. It is not necessary here to discuss the relative merits of three-wheel and tandem rollers in any detail, but advantages may also, of course, be claimed for the tandem type. The question of the work to be done has considerable bearing upon the choice.

The roller is driven by a two-cylinder vertical paraffin engine placed longitudinally on the frame. The engine is water-cooled, and a large radiator is placed at the back of the machine, as is clearly shown in Fig. 2. The engine has a capacity of 20 h.p. at 1,000 r.p.m., and is fitted with high-tension magneto, governor and water-circulating pump. Petrol is used for starting. The drive is taken from the engine to a gear-box through a short shaft with flexible couplings at each end. This shaft is indicated both in the side elevation given in Fig. 3, and in the plan given in Fig. 4. Two clutches are provided on the gear-box for forward and reverse running, so that the gears are not disengaged when reversing. This is an important feature of the machine, since reversing takes place on a road roller probably more frequently than on any other type of machine, and the double clutch arrangement adds to the convenience of driving, and saves wear and tear on the gear teeth. The gear-box is arranged to give three speeds, forward and reverse, of 2·5 miles, 1 mile and 0·5 mile an hour. All gear changes are effected by one lever. The gear wheels are machine cut and hardened, and the gear shafts are carried on ball, or roller, bearings. The gear-box is completely enclosed, and the wheels are self-lubricating, the whole arrangement being on the lines of a modern motor vehicle. Final transmission from the gear-box to the driving rollers is by two trains of spur-gearing, which are enclosed in sheet-iron guards. These drives are indicated in Figs. 3 and 4.

Rollers of this type are built by Messrs. Ruston of 6 tons, 7 tons, 8 tons and 9 tons weight. The example illustrated in our figures and with which we are dealing is of 8 tons. This is the empty weight. In working trim the roller weighs 8 tons 2 cwt. All rollers are of hard cast iron, while the driving rollers have steel spokes. The front roller, which is made in two sections to allow of easy steering, is 3 ft. 6 in. diam. by 3 ft. 6 in. wide. The rear rollers are 5 ft. diam. and 1 ft. 3 in. wide. The wheel base is 10 ft. 1 in. and the width rolled 5 ft. 9 in. The steering arrangement, which is clearly shown in Figs. 3 and 4, is similar to that which Messrs. Ruston fit to their steam rollers. The front roller is carried in a box section steering fork which is operated by chains. The pulleys on which the chains are wound are carried on a shaft operated by a totally enclosed worm gear driven by the steering hand-wheel. Two brakes are provided, one being a foot brake acting on a drum on one of the shafts of the gear-box, and the other a screw brake acting on a drum on the driving axle. Patent spring scrapers of similar type to those used on the firm's steam rollers are fitted to the driving rollers, and an angle scraper is fitted to the front roller. A pulley 18 in. diam. for driving machinery by belt is arranged at the side of the roller, as can be seen in Fig. 1. It is arranged to run in either direction. The capacity of the paraffin tank is 18 gallons, and, as before indicated, a small petrol tank is fitted for starting purposes. The starting handle for the engine is below the radiator at the rear of the machine. The shaft on which this handle is mounted also carries the belt pulley for the cooling fan. The complete roller presents a very smart appearance, and should be a useful and efficient tool. The fact that when geared for the slowest speed of 0·5 mile an hour the engine is still running at full speed gives ample power for climbing steep hills, and the machine should easily meet the onerous conditions of many foreign markets.

THE LOCOMOTIVE BOILER EXPLOSION AT BUXTON.

AN explosion of the boiler of a railway locomotive is now fortunately a rare occurrence, and it is many years since we have had to report a disaster of so serious a character as one which took place on the London and North-Western Railway, Buxton, on Friday, November 11. In the early morning (12.45 a.m.) a goods train was just leaving the station on its way to Oldham when the boiler exploded with what is described as a "deafening roar." The driver and fireman, who were on the footplate, were both blown away, and their bodies were subsequently found in a plantation 450 ft. distant. They were terribly mutilated and were practically beyond recognition. Fragments of the engine were scattered in all directions and some embedded in the ground, it is stated, half a mile away; a portion of the permanent way was torn up and several wagons behind the engine were destroyed, while some windows in the vicinity were broken. The havoc occasioned was so great that it was some hours before a breakdown gang could clear the road for traffic.

On Wednesday, November 16, an inquiry by the coroner for the High Peak district was opened at the Town Hall, Buxton, an influential jury being empanelled, and various representatives of the London and North-Western Railway Company, the National Union of Railwaymen, and the Associated Society of Locomotive Engineers and Firemen were present. In the first instance the coroner read the evidence (previously taken) as to the identification of the deceased men, as follows:

James Greenwood, railway engine driver, Oldham, identified one of the bodies as that of his brother, Walter Fletcher, of Oldham, 28 years old, and fireman in the employ of the London and North-Western Railway Company. Witness was quite sure of identity because of the conformation of the teeth.

George Holmes, Oldham, identified the other body as that of his father, William Holmes, 50 years of age, engine driver, who had been in the employ of the London and North-Western Railway and had had about thirty-two years' experience. Witness was quite sure that the grey sock worn by the deceased was his father's, and he also produced other tokens as proofs of identity, such as a knife, purse, &c.

The following evidence was then given:—

John Hannah, Stockport, deposed that he was guard

of the train, and which was taking minerals from Buxton to Oldham. He had just given the signal to the driver to start, and was walking to his van when the explosion occurred, and he was thrown to the ground. The engine had only gone a very short distance. The weight of the train was 496 tons and the capacity of the engine 510 tons.

Sergeant McDowell said that in company with Superintendent Brady he visited the railway sidings and found that an explosion had occurred and that the engine was badly smashed. They searched for the bodies, and found them in the plantation, and witness gave various gruesome details of the injuries the victims had sustained. The engine, he said, was terribly shattered and the rails beneath it torn away and doubled up like pin wire. The barrel of the boiler was practically intact, and so was the tender.

R. Winstanley, St. Helens, said he was a London and North-Western Railway engine driver, and knew the engine No. 134, which subsequently exploded, and brought it to Buxton from Widnes on Thursday, November 10. When he detected any defect in an engine it was his duty to record it in a book, and on this occasion he entered in the record book that "the steam gauge wanted changing, it was registering 300 lb.; both injectors would not work when high in steam, and the engine brakes needed adjusting." When the gauge registered 300 lb. it was, in his opinion, out of order, or the safety valve was not working correctly. A fair limit of pressure was 200 lb. for an engine of that type.

Replying to a juryman, witness said that when the gauge was showing 300 lb. he did not think the pressure in the boiler was that.

In reply to Mr. Brassington (representing the National Union of Railwaymen) witness said that when the gauge showed 300 lb. the engine was standing, and he presumed it was out of order as the valves were not blowing off, the gauge was comparatively new, and the engine was an exceptionally good one.

Witness, continuing, said that when he found the gauge registering 300 lb., he got it down to 200 lb. because he did not trust it at the higher pressure. With the dampers closed he reduced it to 100 lb. and he kept the engine below blowing-off point. He felt no uneasiness until the gauge got above the 200 lb.

George Moss, Buxton, engine driver in the London and North-Western Railway employ, deposed to having prepared the engine for work the day previous to the explosion, and got it fit for the journey by about midnight.

By the coroner: If the fault was with the safety valve the changing of the gauge would not alter it. A new gauge had been put in, and there was a red mark on it when the steam should blow-off.

Mr. G. A. Dingley, Nantwich-road, Crewe, was the next witness, and said he was the assistant superintendent of the London and North-Western Locomotive Department at Crewe. When a report was made in the engine repair book it was the business of the foreman fitter to read every entry, after which he gave the work out to the proper men to do it. Regarding the entry in the book about the steam gauge it was his experience that the driver from working his engine would know what was wrong—the gauge or the safety valve—and this entry to his mind would suggest that the gauge only needed attention. They were not allowed to tamper with the valves as a seal was on them. If the next driver reported the gauge wrong, the safety valves would be taken off, and if he had any suspicion that there was something wrong with the valve the driver could touch a special lever. Witness described to the coroner and jury the construction and working of the valves, and said that if the foreman fitter should, in any special case, consider the valve was at fault, he should stop the engine, remove the valve from the boiler and send it to Crewe works for repair. Witness said he had examined the gauge and debris, but had not at the present moment arrived at what he considered to be the cause of the explosion. There were still parts waiting to be examined, but this could not be done until after the Board of Trade examination fixed for the coming Friday.

Questioned by the coroner, witness said there were possible causes for the explosion, (1) the boiler being allowed to get short of water, the crown of the fire-box becoming hot, and the injectors put on which would cause a flow of fresh water into the boiler and produce a sudden raising of steam; (2) some foreign substance or explosive being thrown into the fire-box; and (3) the safety valves not acting properly. The first and second causes were the only two met with in his experience, covering forty years, but he had never heard or read of an explosion caused by a defective safety valve. He had had a case of an explosion caused by a detonator being left among the coal by the colliers, but in reply to the coroner, witness said he could hardly imagine such an explosion as the present one arising from such a cause.

In reply to Mr. Brassington witness said the steam gauge had not been touched since the explosion, and would not be until the Board of Trade Inquiry. With regard to the safety valve, if the gauge was correct and the valve was not blowing-off they would have the valve removed.

By a juryman: The boiler barrel met with practically no damage; the fire-box had collapsed, but the crown of the box gave indication that it had gone first.

In reply to Mr. Mason (of the Associated Society of Locomotive Engineers and Firemen) the action of the lead fusible plugs would be to let the water in and put out the fire.

Witness proceeded to say that the driver would not have started if he had seen anything wrong with the gauge or valve. They could scarcely have gone wrong with only five strokes of the engine. The working life of a boiler would be from twenty to twenty-five years, and that of the fire-box about the same with repairs. There was one of the safety valves intact, and this would be examined.

Replying to the coroner, witness said he could hardly account for an explosive which would cause so much damage if it had been thrown on the fire. It might be possible for an explosive to blow off the fire-box roof and then explode after. The exploded boiler had been repaired by a private firm, and the fire-box was sixteen years old. He had no information as to whether the safety valve was blowing off at the time of the explosion.

Mr. James Denning, assistant works manager at Crewe, said that as a rule the London and North-Western Railway Company made all their boilers there. In the case of a boiler to work at 200 lb. there were three tests, the first being a steam test up to 100 lb. pressure; next a clamp would be put on the safety valve and the boiler tested hydraulically to 300 lb. pressure; the clamp would then be removed, the water dropped to the normal level, and the boiler fired up and tested to 200 lb. pressure.

The boiler in question was built originally by the company in 1905 and went through the tests. It was repaired at Crewe Works in 1907, 1908, 1911, 1914, 1916 and 1918. It was last repaired by Messrs. Beardmore, and went through the repair test up to 100 lb. pressure. It was last repaired by that firm in May, 1921, and the boiler was received back in July, satisfactory so far as the work was concerned. Repairs to the fire-box the last time would be at Messrs. Beardmore's works.

The guard of the train, John Hannah, was at this point recalled by the coroner, and was asked whether he noticed any steam being blown off just before the train started. He replied there was none whatever.

Tom Halstead, Fairfield, Buxton, an engine fitter, said that the previous Thursday he changed the gauge on the engine 134, getting his instructions from the foreman. Nothing, to him, appeared to be wrong with the old one. The gauge he took off was comparatively a new one.

John Hardstaff, Buxton, foreman fitter at the London and North-Western sheds, deposed to the repairs made under his control.

By the coroner: When the gauge registered 300 lb. instead of 200 lb., it was probably wrong. In his experience of twenty-six years there was no possibility of the gauge being right and the valve wrong. He had never experienced a safety valve being defective. Of course if a gauge was going up to 300 lb. when in perfect working order there must be a fault somewhere, but as stated he had not met with such a defect in a valve.

This for the present closed the evidence, and the coroner said the jury would agree with him that they could not possibly complete the inquiry that afternoon. Mr. Dingley had told them that there were three possible causes of the explosion: (1) Shortness of water, (2) some foreign substance getting underneath the boiler, and (3) there was the probability of the safety valve going wrong, which Mr. Dingley had said he had never before heard of. A large quantity of the debris of the engine had not yet been examined pending the Board of Trade Inquiry. It was possible that when that came to be carefully examined something else might turn up, and he (the coroner) would not feel comfortable if he let the jury give a verdict on the evidence now before them. He would therefore adjourn the inquiry until after the Board of Trade had completed their examination, and they would then have the benefit of their report. The date for the adjourned inquest could not be fixed, but it would be left open, and the jury would receive further information.

At the request of a juryman, Mr. Allan Tizard, West-street, Crewe, inspector of boilers for the railway company, was called, and said that the repairs done to the fire-box were that two new half-sides were put in. The last time it was repaired was at Messrs. Beardmore's in May to July of this year, and he was present at the testing of the boiler previous to its being placed on the engine. The boiler was filled with water and hydraulically tested up to 205 lb. per square inch, and afterwards to a working pressure of 200 lb. of steam.

The inquest was then adjourned.

The Surveyors' Institution.—The council have accepted an invitation from the Shropshire, Herefordshire and Mid-Wales branch to hold the annual country meeting at Shrewsbury in 1922. An attractive programme is being prepared for a date, to be fixed later, during June. It has been decided that the interest from the bequest of 500*l.* from the late Mr. T. T. Wainwright, past-president, should be applied for the purpose of awarding a prize to the non-student candidate who obtains the highest number of marks in the intermediate and final examinations combined. This prize will, therefore, correspond with the Galsworthy prize for student candidates.

Loss of a Norwegian Salvage Steamer.—A somewhat unusual occurrence took place off the Norwegian coast a short time ago, the vessel in distress managing to reach port, whilst the salvage steamer which had gone out to the rescue went down. The Haugesund steamer Facto had anchored off Store Färder with engines out of order, and the salvage steamer Neptun went out to her assistance. There was a snowstorm, and a strong current was also running; the Neptun lost her bearings and struck the rocks at Fulebuk. By means of the pumps on board, the crew managed to cope with the water and to keep the engine running throughout the night; the next morning, however, water made its way into the engine room and stopped engine and pumps. All on board were saved, but the Neptun sank almost immediately after the captain had left. The Facto, on the other hand, managed without any assistance.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—The suspension of work on the British Admiralty contracts seems to have deepened the gloom in the purely commercial sections. Though they are now able to quote almost as low as many of their keenest competitors, steel makers have failed to attract any substantial volume of new business. According to reports received from agents in various foreign countries, buyers are waiting for further wages cuts to be translated into still lower selling prices. Until this eventuates they are not prepared to enter into forward contracts of a heavy nature, though they have big orders to place. The result is that the number of Bessemer and open-hearth furnaces in commission in Sheffield and district is actually fewer than was the case a month ago. Moreover, many of these are being run at a loss in order to keep commercial staffs and connections together. The position is viewed very seriously, especially as many firms have received the limit of assistance from their bankers and have difficulty in finding sufficient ready cash to pay wages. Improvement in the high-speed steel trade has again been deferred by the release of huge surplus stocks. Buyers, both at home and abroad, are few, and are able to purchase at lower rates from the Government distribution of war purchases than can be offered by makers at current production costs. Little business of any description is passing in the shipbuilding section. Requirements of engineers' tools are light, and are not sufficient to keep plant running more than half-time. The brighter side of the picture is represented by the manufacture of textile machinery and machine tools for export. What is taken to be the birth of a revival is apparent in a number of useful orders placed by the automobile industry. Increased requirements of the building trades also enable iron foundries to work longer hours.

South Yorkshire Coal Trade.—Business generally is restricted, but in some respects a rather more hopeful undertone prevails. There has been a marked improvement in the demand for all qualities of house coal both for metropolitan and local consumption; but even so, the majority of merchants are working on day-to-day orders. Little improvement is experienced in the demand for best steam hards, even at reduced prices. Export trade is slow at values which leave only a small margin of profit to producers. Cobbles are in better request than for a few weeks, but trade in nuts has shrunk owing to many of the works resuming their former practice of using slacks. Demands for the better grades are not up to the normal, but are sufficient to prevent the further accumulation of stocks at pits. Cokes are a dull market. Quotations:—Best branch handpicked, 39*s.* to 40*s.*; Barnsley best Silkstone, 38*s.* to 40*s.*; Derbyshire best brights, 35*s.* to 36*s.*; Derbyshire best house coal, 34*s.* 6*d.* to 35*s.*; Derbyshire best large nuts, 30*s.* to 32*s.*; Derbyshire small nuts, 27*s.* to 29*s.*; Yorkshire hards, 29*s.* to 30*s.*; Derbyshire hards, 28*s.* 6*d.* to 29*s.* 6*d.*; rough slacks, 17*s.* to 18*s.*; nutty slacks, 15*s.* to 16*s.*; smalls, 5*s.* to 10*s.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—The anticipated drop in Cleveland pig-iron quotations is announced this week. The fall is no more than was looked for, and, indeed, many traders expected it to be heavier. It appears, however, to be agreed that quotations are now approaching figures at which resumption of business may reasonably be expected. The reduction of 10*s.* lowers No. 1 to 105*s.* for home use and 110*s.* for export, and No. 3 G.M.B. to 100*s.* for home consumption and 105*s.* for export. The continued very restricted output of these better-class qualities is apparently quite ample for present small needs, but any material movement in the direction of improved demand, would quickly absorb all the iron available. The inferior grades are abundant and quite a drug on the market. Both for home purposes and for despatch to foreign destinations foundry No. 4 is 95*s.*, No. 4 forge 90*s.*, and mottled and white iron 85*s.*

Hematite.—Though production of East Coast hematite seems to be fully equal to needs, that there is some confidence in the future would appear from the decision to re-start idle furnaces. Two are to be rekindled at the Linthorpe Ironworks, and Messrs. Whitwell are blowing in a couple. The product of this district is the cheapest hematite in the country, and this encourages the hope that buying will extend. There is keen competition for orders, and possibly less than the recognised market quotation of 110*s.* would be accepted in some cases for Nos. 1, 2 and 3 for home use or for shipment abroad. No. 1 is put at half-a-crown above mixed Nos.

Foreign Ore.—There is no new feature in foreign ore. Business is confined to transactions in odd cargoes, and does not promise to extend materially, until stocks have been much reduced and arrears of deliveries against old contracts largely overtaken. Best rubio is put at 27*s.* c.i.f.

Coke.—There is a markedly easier feeling in coke, but sellers still ask up to 30*s.* for average blast-furnace Durhams, which is more than local consumers will pay.

Manufactured Iron and Steel.—The depression in finished iron and steel is quite unrelieved, and improvement of moment is not looked for until after the Christmas holidays. Principal market quotations stand:—Common iron bars, 12*l.* 10*s.*; iron rivets, 16*l.*; medium steel billets, 9*l.*; hard steel billets, 9*l.* 10*s.*; steel boiler plates, 16*l.*; steel bridge, ship and tank plates, 10*l.* 10*s.*;

steel angles, 10*l.*; steel joists, 10*l.* 10*s.*; heavy steel rails, 10*l.* 10*s.*; fishplates, 15*l.* 10*s.*; black sheets, 15*l.* 10*s.*; and corrugated galvanised sheets, 18*l.* 10*s.*

Cleveland Miners' Wages.—At a joint meeting of Cleveland ironstone mine owners and miners' representatives this week, the owners suggested the abolition of the 8*s.* a day minimum as well as the dropping of the 5½ per cent. increase granted about six weeks ago. The claim was resisted by the miners' representatives, but it was ultimately decided that the 8*s.* minimum should cease at the end of the present week. This means that commencing Monday, no man will be paid more than the base rate and agreed percentage actually earned by him. It was agreed, however, that the increase of 5½ per cent. should continue until January, when the wage rates will again be discussed.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—No change for the better has taken place in the Scottish steel trade yet, and in some quarters the outlook is somewhat more obscure. Although prices have been gradually reduced buyers have not been tempted to come forward, and the most of the business being picked up is of little account. However, it has been the means of preventing a complete stoppage in several establishments, as few of them can manage to keep mills going the full week. The inquiries recently in the market have not resulted in much business, and many of these are now being looked upon only as feelers. It is realised generally, nevertheless, that a goodly amount of fresh business could be placed locally if buyers were assured that better conditions could not be secured by them by a little longer delay. The shipbuilders are steadily working off their contracts for new tonnage, and that outlet for the steel trade is getting assuredly less. Plates and sectional material are therefore in very poor demand, while black sheets are in a like category, and little booking has followed the recent reductions in prices. The general export trade is far from satisfactory. The current prices are as follow:—Boiler plates, 15*l.* 10*s.* per ton; ship plates, 10*l.* 10*s.* per ton; sections, 10*l.* per ton; and sheets, 12*l.* 15*s.* pet ton, all net, delivered Glasgow.

Malleable Iron Trade.—The state of the malleable iron trade of the West of Scotland is not very encouraging, and reports indicate that there has been little response on the part of consumers to the cut made in prices last week. With "crown" bars down to 12*l.* 10*s.* per ton, it was expected that business would be brightened up even a little, but the number of shifts has not had to be increased nor does that contingency seem likely in the meantime.

Scottish Pig-Iron Trade.—There has been little movement in the pig-iron trade of Scotland during the past week and producers have had to take a more serious view of the present position. The output is not being taken up, which means that the makers are carrying stocks of iron produced at high cost, and every reduction in price means a definite loss to them. If no improvement comes along soon many furnaces will be damped down in the near future, and the forthcoming holiday period will be rather extended. The present unsettled state of the world's markets is being severely felt in the Clyde area, and until a new *regime* comes into being little or no improvement can be looked for. To-day's prices may be taken as follows:—No. 1 foundry iron, 6*l.* 7*s.* 6*d.* per ton; No. 3, 6*l.* 2*s.* 6*d.* per ton; and hematite, 6*l.* 7*s.* 6*d.* per ton, net, the former at makers' works and the latter delivered at the steel works.

Wages in the Iron Trade Reduced.—Mr. John M. MacLeod, C.A., Glasgow, has made the following intimation to Messrs. James C. Bishop and Owen Coyle, joint secretaries of the Manufactured Iron Trade Conciliation and Arbitration Board: "In terms of the remit, I have examined the employers' books for September and October, 1921, and I certify the average net selling price brought out is 15*l.* 10*s.* 2·17*d.*" This means a decrease in the wages of the workmen of 15 per cent. on basis rates.

Shipbuilding.—The shipbuilding returns for the past month do not make very inspiring reading because the output from the different districts only amounts to 10 vessels of 22,465 tons, which is the lowest tonnage for the whole year. The previous lowest month's total was January, with 14 vessels of 23,585 tons. The following are the figures:—

	Vessels.	Tons.
The Clyde	7	15,850
The Forth	—	—
The Tay	1	6,000
The Dee and Moray Firth ...	2	615
Total	10	22,465

The Clyde total of 7 vessels amounting to 15,850 tons, is the second lowest for the year, and compares badly with February, when 25 vessels totalling 82,431 tons were launched, and even with last month, when the figures were 14 vessels of 55,979 tons. The year's output to date is 202 vessels of 421,845 tons, which is the lowest return for a number of years, and is over 143,000 tons behind the figures for the corresponding period of last year, and nearly 207,000 tons worse than for the same period of the record year 1913. The outlook in the trade is very black just now, as order books are very bare and no new contracts have been reported recently.

NOTICES OF MEETINGS.

THE INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Saturday, December 3, at 4 p.m., in the College of Technology, Manchester. A discussion will be opened on the Jar Ram Moulding Machine. Subject, "Is the Jar Ram Machine Suitable for both Heavy and Light Work?"

THE SOCIETY OF ENGINEERS.—Monday, December 5, at 5.30 p.m., in the Apartments of the Geological Society, Burlington House, when a paper will be read on "Northwich Sewerage and Sewage Disposal Works," by Mr. W. M. Beckett, M.B.E., A.M.Inst.C.E., M.S.E., illustrated by lantern slides.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Monday, December 5, at 5 p.m., General Meeting of Members.

THE JUNIOR INSTITUTION OF ENGINEERS.—Monday, December 5, at 2.30 p.m., visit to Messrs. Duroglass, Limited, Walthamstow. Friday, December 9, at Royal United Service Institution, Whitehall, Presidential Address by Mr. C. H. Wordingham, C.B.E., M.Inst.C.E. Chair to be taken by Lord Weir of Eastwood, P.C., D.L., LL.D., at 7.30 p.m.

THE CLEVELAND INSTITUTION OF ENGINEERS.—Monday, December 5, at 6.30 p.m., in the Hall of the Cleveland Technical Instutute, Corporation-road, Middlesbrough, when a paper on "The Formation of Pearlite in Steel," by Mr. J. H. Whiteley, will be read and discussed.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—Monday, December 5, at 7 p.m., at the Y.M.C.A., Albion-place, Leeds, when Mr. J. P. Grassick will read his paper on "The Locomotive from a Footplate Point of View." The chair will be taken by Mr. A. C. Stamer.

THE ROYAL SOCIETY OF ARTS.—Monday, December 5, at 8 p.m.: Cantor Lecture, "Processes of Engraving and Etching," by Mr. Arthur M. Hind, O.B.E., M.A., Slade Professor of Fine Art in the University of Oxford (Lecture II). Tuesday, December 6, at 4.30 p.m.: Dominions and Colonies Section, "British Columbia—The Awakening of the Pacific" (with cinematograph illustrations), by Mr. F. C. Wade, K.C., Agent-General for British Columbia. His Grace the Duke of Devonshire, K.C., G.C.M.G., G.C.V.O., Governor-General of Canada, 1916–21, will preside. Wednesday, December 7, at 8 p.m.: Ordinary Meeting, "Literature and International Relations," by Mr. Emile Cammaerts (Anglo-Belgian Union). His Excellency the Belgian Ambassador will preside.

THE INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH; BURNLEY SECTION.—Tuesday, December 6, at 7 p.m., in the Technical College, Ormerod-road, Burnley, when Mr. W. H. Cook, of Heaton Chapel, will speak on "Foundry Problems." Mr. H. Harling will take the chair.

THE INSTITUTE OF METALS.—Tuesday, December 6, at 7.30 p.m., in the Chamber of Commerce, New-street, Birmingham, a paper by Mr. George W. Mullins, M.B.E., "The Early History of Copper and Bronze," will be read and discussed. Thursday, December 8, at 8 p.m., at the Institute of Marine Engineers, 85 to 88, The Minories, Tower Hill, E. 1, a paper by Mr. S. A. E. Wells, "Casting in Metal Moulds," will be read and discussed. (Joint meeting with the Institution of British Foundrymen.)

THE INSTITUTE OF MARINE ENGINEERS, INCORPORATED.—Tuesday, December 6, at 6.30 p.m., a paper will be read on "Life at Sea, particularly in Sailing Ships," by Sir D. Wilson-Barker. Cinema film. Lantern views. Ladies' night.

THE INSTITUTION OF SANITARY ENGINEERS.—Wednesday, December 7, at Caxton Hall, Caxton-street, Westminster, when a Sessional Meeting will be held on "Town Planning," by Mr. S. A. Hill-Willis. Mr. Nandy Hoskins, President, will take the chair at 7 p.m. Discussion to follow.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Wednesday, December 7, at 2.30 p.m., at the College of Technology, Manchester (Room E.17), a paper entitled "Notes on Air Measurement" (illustrated by lantern slides) will be read by Mr. E. R. Dolby.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—WIRELESS SECTION MEETING.—Wednesday, December 7, at 6 p.m., in the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "An Investigation of Transmitting Aerial Resistances," by Mr. T. L. Eckersley, B.A., B.Sc.

THE ASSOCIATION OF MANAGERS OF SEWAGE DISPOSAL WORKS.—Thursday, December 8, at 2.30 p.m., Presidential Address by Mr. Joseph Garfield, M.Inst.C.E. Papers: "Comparative Methods of Lifting Sewage," by Mr. P. G. Lloyd, F.C.S.; "Notes on Keeping Records and Accounts of Sewage Disposal Works," by Mr. Percy Lamb. 6.30 p.m.: Annual dinner. Friday, December 9, at 11 a.m., visit to the Kingston-on-Thames Sewage Disposal Works.

THE MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.—Thursday, December 8, at 2.30 p.m., in the Mappin Hall, The University, St. George's-square, Sheffield. Paper, "The Metering of Large Volumes of Air and Gas by Means of the Venturi Tube," by Mr. J. L. Hodgson. The following paper will be open for discussion: "Friction Co-efficient of Minerals," by Mr. S. Nettleton.

THE OPTICAL SOCIETY.—Thursday, December 8, at 7.30 p.m., an Extraordinary General Meeting will be held at the Imperial College to consider alterations of Rule VII. An Ordinary Meeting will be held immediately after the Extraordinary General Meeting, when the following papers will be presented and discussed: "The Physical Meaning of Spherical Aberration," by Mr. L. C. Martin, D.I.C., A.R.C.Sc., B.Sc.; "An Autostroboscope and an Incandescent Colour Top," by Dr. F. Lloyd Hopwood, A.R.C.Sc., F.Inst.P.; "Achromatic One Radius Doublet Eyepieces," by Lieutenant-Colonel Gifford, F.R.A.S.

THE INSTITUTION OF WATER ENGINEERS.—Friday and Saturday, December 9 and 10, at the Apartments of the Geological Society, Burlington House, W. The chair will be taken by the president at 10 a.m. The following papers will be read and discussed: "The Manchester Water Works," by Mr. L. Holme Lewis, M.Inst.C.E.; "Adsorption in Sand Filters," by Mr. John Don, B.Sc., F.I.C., Asso.M.Inst.M.E.; "Indicating and Recording Instruments," by Mr. C. F. Newton, B.Sc.; "The Louth Flood of 1920," by Mr. P. B. Crosthwaite, B.A.I., M.Inst.C.E.; "Hydrological Conditions in the Chalk at Compton, West Sussex," by Mr. D. Halton Thomson, M.A., Asso.M.Inst.C.E.; Discussion on the Final Report of the Water Power Resources Committee.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The committee appointed by the District Coal Board to go into the question of an "allowance" for the lower paid men has failed to come to an agreement, and the matter will be dealt with at the delegate conference of the South Wales Miners' Federation to be held on Saturday next. The trouble is that in view of the fact that selling prices are so near to the cost of production, and in many cases less, and the prospects of securing higher prices remote, the owners do not feel justified in increasing output costs, though they recognise that the plight of the lower paid men is hard. Meanwhile there is practically no change in the condition of affairs on the coal markets. Prices generally are round the levels ruling a week ago, and though the volume of business is perhaps greater there are still ample supplies of coal to meet the demand. Best Admiralty large ranges from 25*s.* to 25*s.* 6*d.*, seconds 24*s.* 6*d.* to 25*s.*, dry large from 23*s.* to 24*s.* 6*d.*, and the leading Monmouthshires from 22*s.* to 23*s.* Smalls continue tight and by themselves best steams command 18*s.*, ordinaries 16*s.* 6*d.*, but with large could be secured at a discount of about 1*s.* per ton. Dry smalls are in poor request and range from 11*s.* to 14*s.* Chartering on the freight market remains active and the recent volume of shipments are likely to be maintained.

Dock Pilots' Tariff.—For some months past negotiations have been proceeding between the Shipping Federation and the National Transport Workers' Union in respect to a revision of the tariffs and working conditions of dock pilots, riggers and boatmen at the South Wales ports. These negotiations broke down a couple of weeks ago and the Shipping Federation decided to bring their own tariffs into operation on Monday last, which they did. Their tariff represents generally a decrease of 60 per cent. on the old rates, but are about 60 per cent. above the pre-war tariffs. The men's tariff is about 100 per cent. above pre-war rates. The men are offering to work on their own tariff, but their services generally are being refused, and the work of shifting ships in dock carried out by the vessel's own crews. For dock piloting vessels up to 250 tons net the men claim 17*s.* 6*d.* per move and for those 3,000 tons to 3,500 tons 60*s.* per move against the owners' offer of 10*s.* and 40*s.* respectively.

Iron and Steel Trades.—Orders for Welsh tin-plates have been booked for delivery well into next year and the market generally is steady, with the outlook fairly promising. About 75 per cent. of the mills are now regularly employed and inquiries are circulating from Holland, Spain, Scandinavia and also the Far East. The cheaper price of plates as compared with American quotations, is causing some inquiry from across the Atlantic, Central America and Mexico in particular. For delivery this month 21*s.* 3*d.* f.o.t. is indicated.

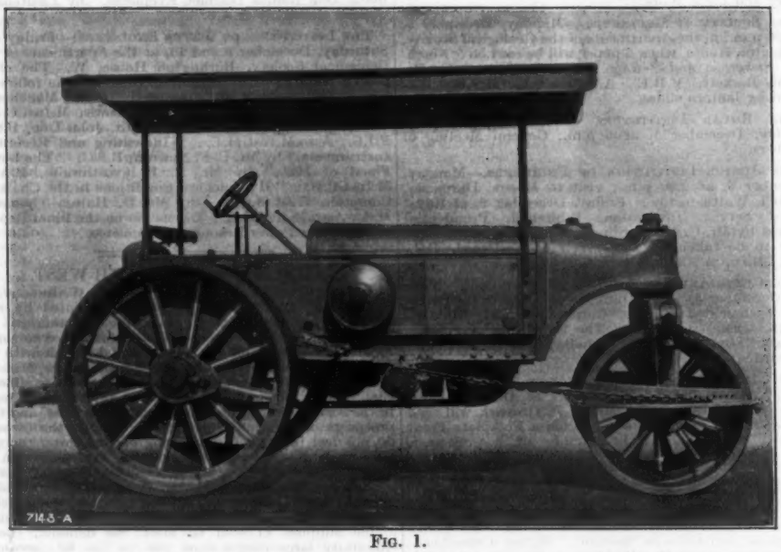
PERSONAL.—Messrs. Boving and Co., Limited, 56, Kingsway, W.C. 2, state that they have a complete new set of lantern slides showing examples of modern water turbines and hydro-electric installations available for lecture purposes. They can be loaned to responsible members of institutes, technical schools, &c., on request. —Messrs. J. Mitchell and Partners announce that the address of their London office has been changed from 33, Old Jewry, London, E.C. 2, to St. Margaret's House, 57 and 59, Victoria-street, Westminster, S.W. 1. Their London office telephone number has also been changed from City 392 to Victoria 1387. Their Newcastle office address remains unchanged.

THE GERMAN MERCHANT NAVY.—The recovery of the German merchant navy is progressing at a very fair pace and during the present year the tonnage has increased from 428,000 tons to about 700,000 tons. At the larger German yards 45 vessels are stated to be in course of construction, and a number of foreign vessels are being purchased. Thus seven good boats of the Swedish Johnsen Line have just been transferred, much to the regret of the Swedes. Their aggregate tonnage is 46,340 tons deadweight and amongst them are the two sister vessels Axel Johnsen and Annie Johnsen, built at Lindholmen some ten years ago, the first Swedish-built ocean-going boats. The types at present attracting most attention in Germany are vessels of 10,000 tons to 15,000 tons deadweight.

8-TON THREE-WHEELED MOTOR ROAD ROLLER.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

(*For Description, see Page* 759.)



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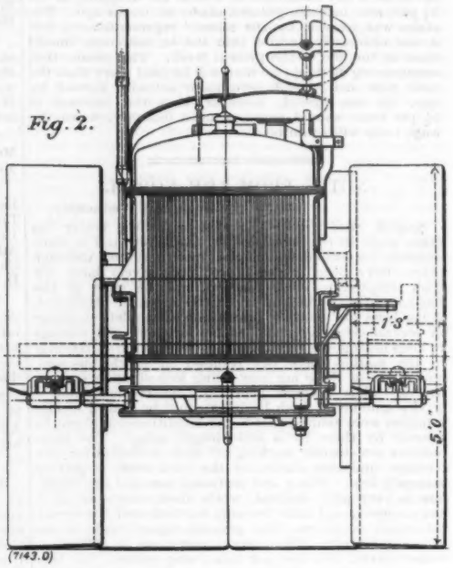

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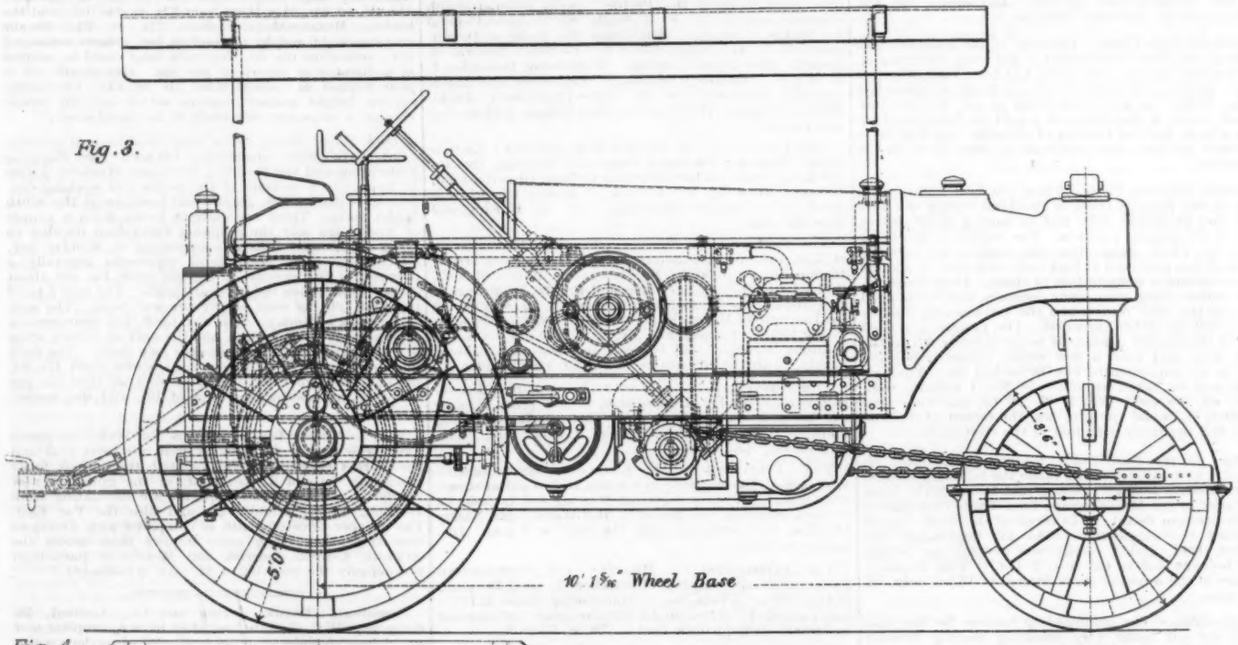

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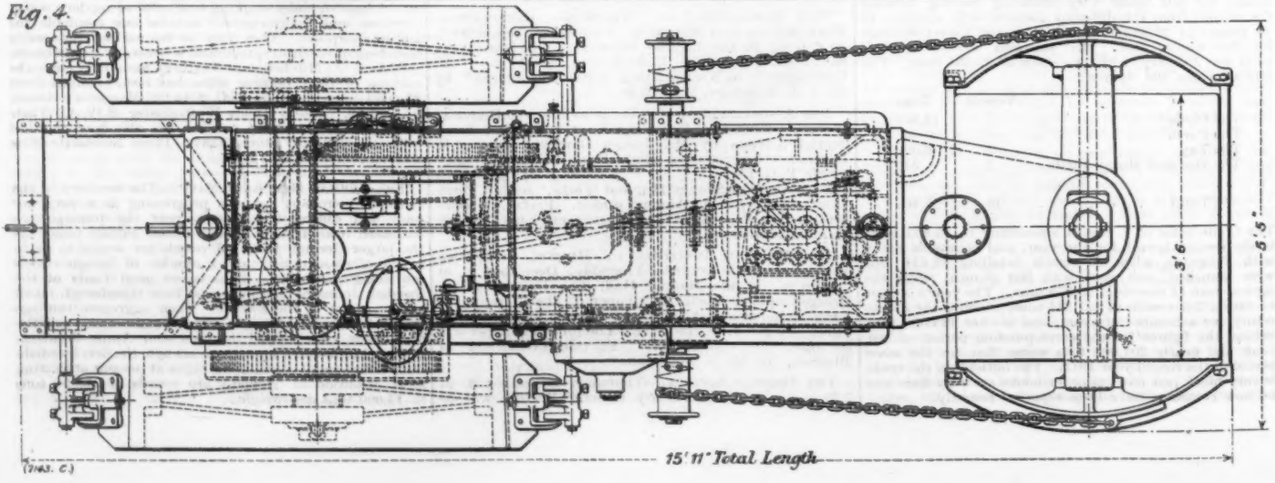

"APOLLO" 2 3/4-IN. HOLLOW SPINDLE TURRET LATHE.

CONSTRUCTED BY MESSRS. POLLOCK AND MACNAB (1919) LIMITED, ENGINEERS, BREDBURY, NEAR STOCKPORT.

(*For Description, see Page* 758.)

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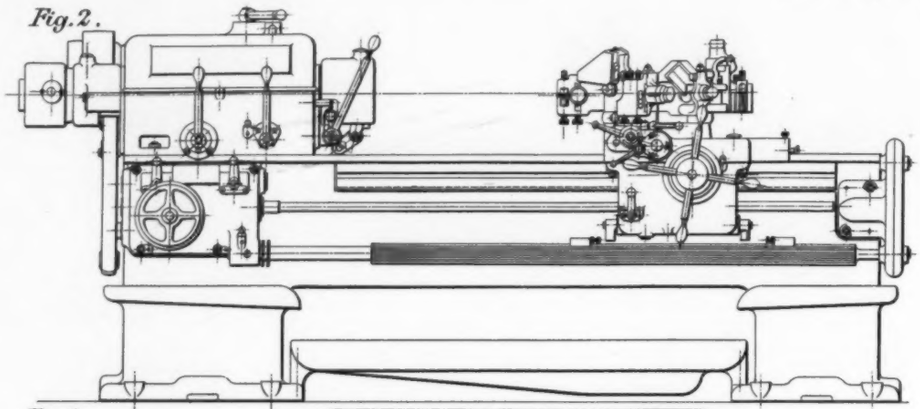

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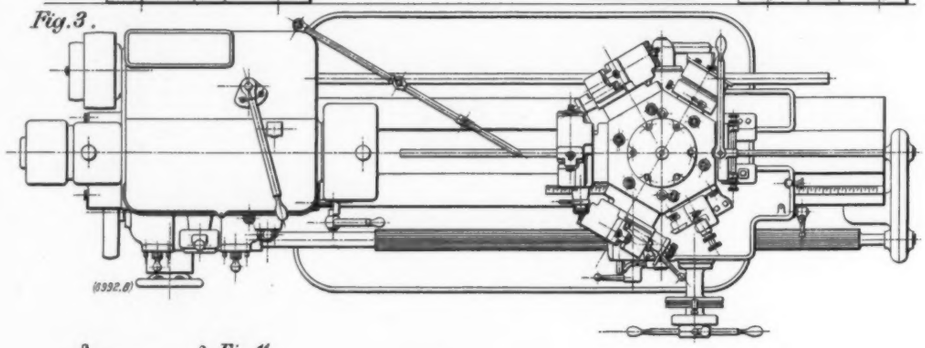

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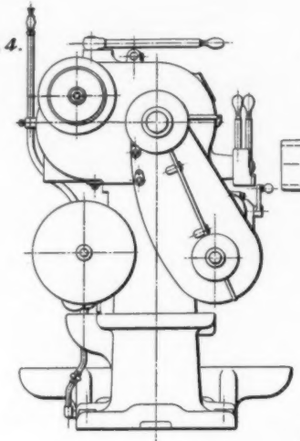

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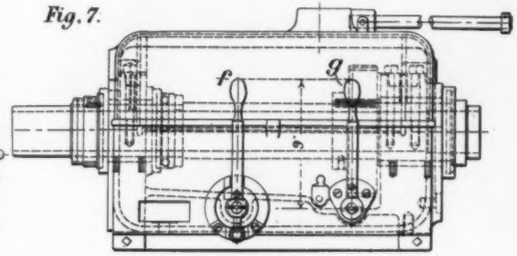

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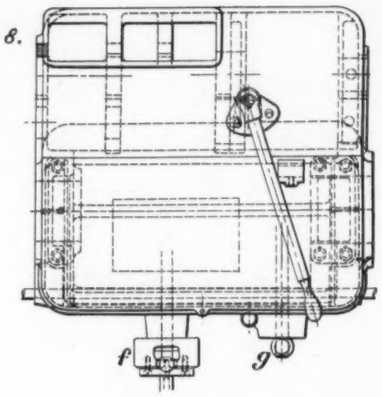

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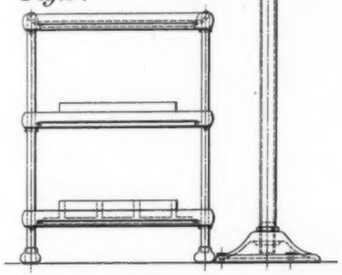

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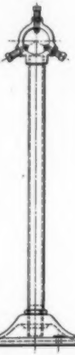

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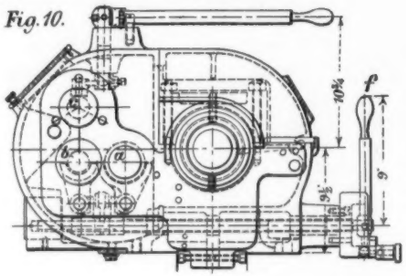

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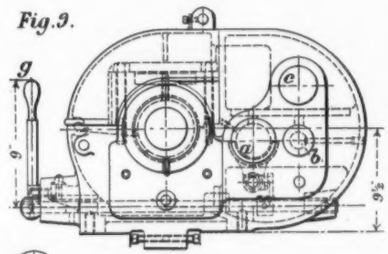

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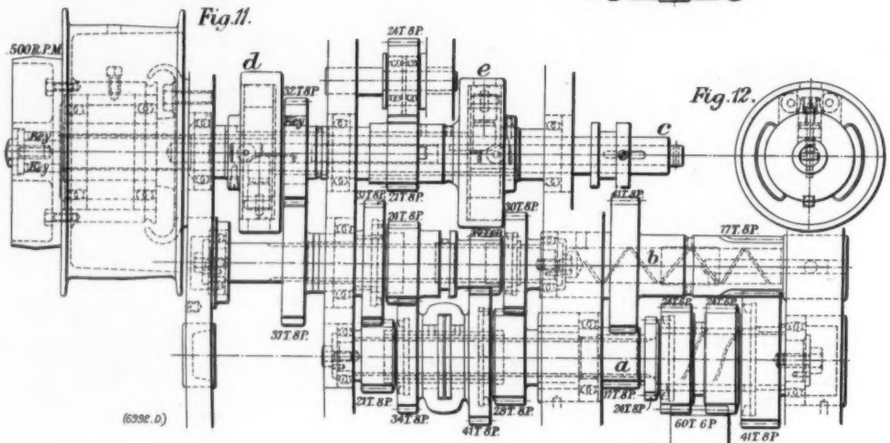

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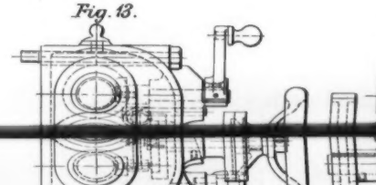

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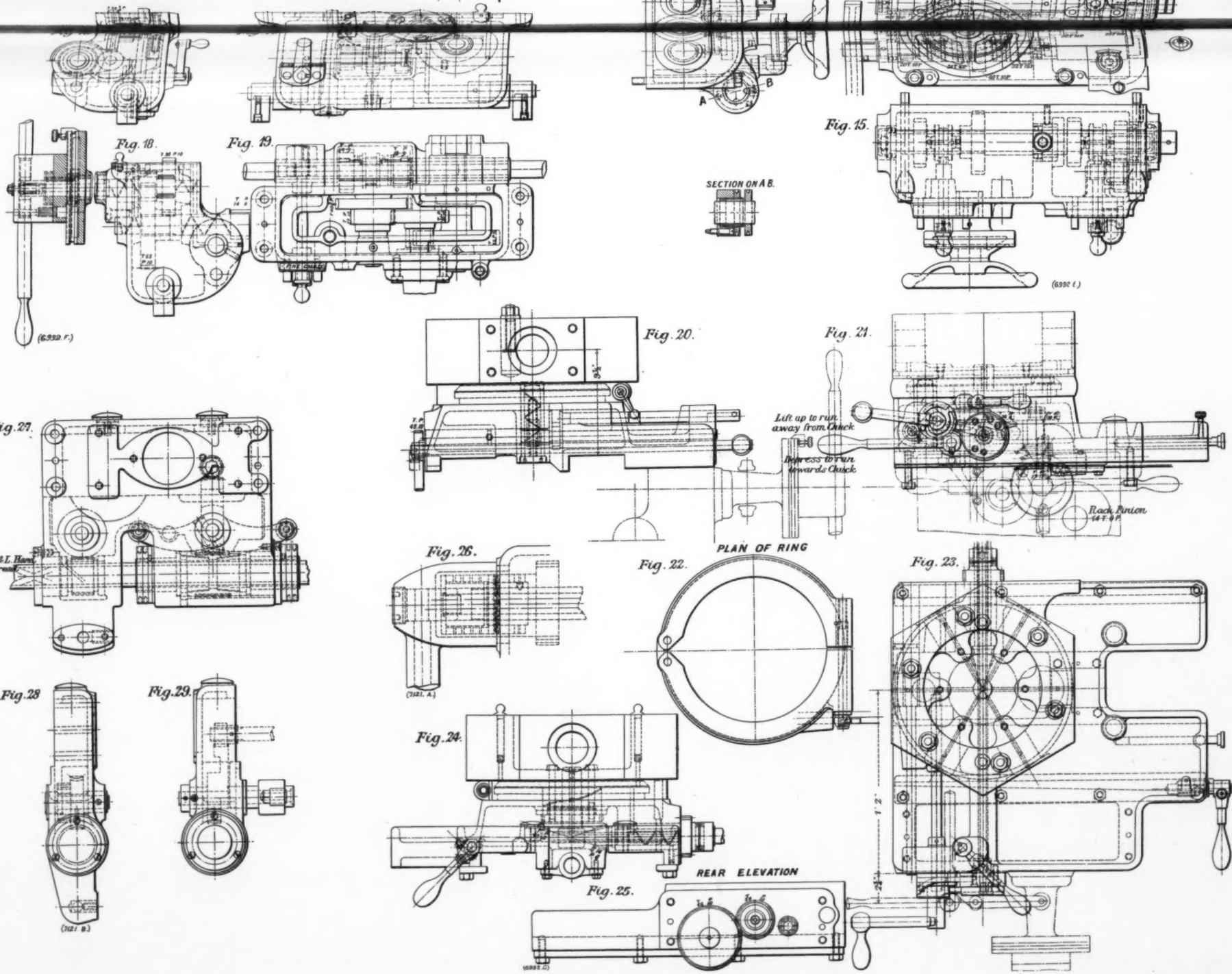
Fig. 15.
SECTION ON A B.
Fig. 18.
Fig. 19.
(6332 f.)
(6332 f.)
Fig. 20.
Fig. 21.
Lift up to run away from Chuck
Depress to run towards Chuck
Rack Pinion 14 T 6 P.
Fig. 27.
R & L. Hand Thread
Fig. 26.
(7121. A.)
PLAN OF RING
Fig. 22.
Fig. 23.
Fig. 28
Fig. 29.
(7121. B.)
Fig. 24.
REAR ELEVATION
Fig. 25.
1' 2"
2½"

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ADVERTISEMENT RATES.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

The charge for Advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12s. per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

SUBSCRIPTIONS, HOME AND FOREIGN.

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Thick paper copies	£3	3	0
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Thin paper copies	£3	3	0
Thick paper copies	£3	7	6

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Offices for Publication and Advertisements 35 and 36, Bedford Street, Strand, London, W.C.2

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3383 and 8598 GERRARD.

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NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 761.

ENGINEERING.

FRIDAY, DECEMBER 2, 1921.

THE NEED FOR EDUCATION IN ECONOMICS.

Of all branches of human knowledge none touches daily life so intimately as economics. The technical sciences, indispensable as they are to the progress—even to the continued existence—of mankind, must always remain to some extent the province of experts, but at every stage in life we are bound to encounter practical problems on which our livelihood depends and which we have to solve for ourselves. The solving of such problems is nothing more nor less than the application of the science of economics. The anchorite, whose material needs are at a minimum and whose object in life is mortification of the flesh, may take a pride in defying economic law, but the ordinary citizen cannot risk quarrelling with his bread and butter. In spite of this, the study of economics is curiously neglected. The average man apparently thinks he knows all that there is to be known on the practical side of the subject and is persuaded that economic theory is abstruse, dreary and remote. In this he is generally doubly mistaken.

The economic laws under which we live are not the creation of any theorist nor the product of any speculative school, but are the results of centuries of experiment, and however numerous may be the imperfections of the present social system its practical superior has yet to be discovered. It would be well if the average citizen would pay closer attention to the economics of the conditions under which he lives and must live. This is particularly the case to-day when determined effort is being made on an international scale to substitute revolution for evolution, to forsake the business of normal industry and to embark on adventures of a dangerously speculative character. During the last four or five years the enemies of the existing order have been operating a stream of propaganda in factories, offices, homes and public places with the object of undermining the foundations of the industrial system. Socialist doctrines have been promulgated in the past, but the intensity and volume of the present campaign is a new factor which must be reckoned with and withstood by every legitimate means.

The prevalence of unrest, ca' canny, and strike fever, with consequent unemployment, are at once the measure of the revolutionary effort and the criterion of its success. By dint of skilful organisation and the frequency of their assaults the extremists are becoming a danger to national stability, and a menace to the continuance of private enterprise as the mainspring of our industrial and economic life. The current type of unrest is not a plant of ancient growth, nor is there any mystery about its origin. Its causes are ascertainable and its effects self-evident. The disruptive ideas that have taken a hold of the labour world did not spring up of their own accord: they have been sown with deliberation and cultivated with discernment. Day by day more and more workmen absorb revolutionary sentiments until they come to believe that they are the victims of an unjust oppression that can only be ended by the abolition or expropriation of the employing classes.

It is not a little strange that the people who are marked for supersession under the proposed *régime* should take so languid an interest in the preparations that are being made. Mere indifference is a very unsound attitude, and one cannot suppose they plead ignorance of a programme which is advertised frankly. Many prominent employers in the country, whose authority cannot be questioned, have recently called attention to the urgent need that exists for a campaign for convincing the workers that their prosperity can be secured only on evolutionary lines which conform to economic law. The present unrest has largely been brought about by propaganda, and the best way to meet it is by a similar activity. It is true that in this matter the defence is at a relative disadvantage as compared with the attack, but the principles at issue are so important that they cannot be abandoned without a sustained and comprehensive effort. The organisation of a defensive propaganda is a business matter, and men of business literally cannot afford to stand aside and allow judgment to go by default.

No industrial revival can come without the co-operation of labour, and the goodwill of labour will not be forthcoming until it is persuaded that it is not being asked to exert itself without due warrant, and until it is satisfied that the reward of its effort will be a fair share of the product of industry. Labour is never likely voluntarily to consent to give higher production or to accept lower wages until it is convinced that the demand is not unjust or unnecessary. Let it not be forgotten that labour is being asked to swallow a pill of exceeding bitterness. The war brought unexpected prosperity to many manual workers and they are naturally reluctant to relinquish ground already won. Allowance must also be made for the reaction of disappointment which was inevitable after the non-fulfilment of facile half-promises uttered in good faith but on insufficient grounds by optimists in the first enthusiasm excited by the victorious issue of the war.

In the condition at which we have now arrived a concerted effort to place the real facts of the situation before the workers is not only desirable but necessary. This is an easy thing to say, but it is fairly evident that such a concerted effort will involve much work and not a little expense. Piecemeal efforts by individuals and individual firms cannot meet the situation, and however ably they are conducted they cannot cover the ground. The circumstances as they stand can only be dealt with by some central body which shall fairly represent all the interests concerned. The matter is not one for the Government. Expenditure on propaganda is not a proper use for public money, and although it might be claimed with much truth that the matter is one of education rather than propaganda, it is fairly evident that a large party in the country would not be prepared to see the matter in that light, while in any case it is certain that the Government has no intention of acting in this capacity.

The conditions call for a special body which shall devote itself to the work, and it is in every way fortunate that such a body is in active existence. This body, which bears the title of "National Propaganda" and has its headquarters at 3B, Dean's Yard, Westminster, has, during the last few years, studied the question of how to bring a knowledge of practical economics to the ears of the people in an acceptable form. It has been able to obtain definite results of proved value in this direction, notwithstanding the fact that the funds at its disposal have been inadequate for the task of conducting operations on a sufficient scale. It must be remembered in this connection that those who seek to defend the existing order of society by means of propaganda are at a disadvantage financially as compared with those who direct the stream of socialistic teaching. The former have to rely on voluntary contributions from home sources, while the latter appear to be able to obtain considerable extra revenues from foreigners who are apparently of so generous a disposition that they can afford to subsidise educational schemes which do harm to this country.

Lack of space prevents us from giving a detailed account of the various activities undertaken and carried through by "National Propaganda" in the interests of private enterprise, and further information can be obtained by writing to the director of the organisation. We may say, however, that the type of propaganda that issues from Dean's Yard is based on conscientious research, is formulated with moderation and is actuated by the spirit of square dealing between man and man in all walks of life. Those responsible for the policy of "National Propaganda" believe in the motto which assures us that truth is bound to prevail in the long run, and they concentrate their efforts first on the

discovery, and then on the dissemination, of the facts of the case. Employers who have their own and the nation's interests at heart should generously support the Local Committees which are being established under the auspices of "National Propaganda" at different centres throughout the country. Times are unquestionably bad, and the majority of firms are faced with the necessity for economy, but it is unwise to neglect to pay the premium on an insurance policy or to fail to call in a surgeon when an operation is necessary. It may be inconvenient to find the money for combating error, but if the diseases that spring from neglect of precautionary measures are permitted to run their course unchecked the results may be not only inconvenient but fatal.

THE MOTOR CYCLE SHOW AT OLYMPIA.

Although the motor-cycle industry finds its greatest market among that section of the public who cannot afford to buy motor cars it appears to be in a much healthier and stronger position than the motor-car industry. For some reason or other the British car builder has always found it difficult to compete with imported vehicles, and a very short observation of the cars on the road is sufficient to show how much business awaits our own manufacturers when they discover how to obtain it. Fortunately the same cannot be said of the motor-cycle industry. The British makers of motor cycles have reason to be proud of the fact that their machines have acquired an almost complete monopoly of the roads, and although a few of the best foreign motor cycles still find a market, the predominance of the British product becomes continually more marked. So far as push-cycles are concerned, British machines established their superiority many years ago, and their command of the market is so complete that if one wanted a foreign machine it would be difficult to know what make to ask for or where to procure it. A very large export trade in both motor cycles and push cycles has also been built up, and though this is languishing at the moment for the same reasons as are affecting other exports, there is reason to believe that the qualities which enabled it to be won will ensure its revival as soon as circumstances become more favourable.

The annual exhibition of cycles and motor cycles which opened at Olympia last Monday, demonstrates very clearly the lead which this country has obtained in connection with the machines in question, although, of course, the space which any particular firm occupies at the show has no necessary relationship with the number of cycles or motor cycles it has on the roads. Moreover, like the motor-car show, the exhibition is becoming such a public function that a detailed examination of the exhibits is increasingly difficult. There is nothing to be said about the push cycles except that prices are lower, a standard man's roadster machine being generally listed at about 12*l.* to 14*l.*, although some were listed at less than 10*l.* Motor cycles seem to be falling into three classes. At the lower end of the scale is the light-weight machine, rated at from 2 h.p. to 3 h.p., with a single-cylinder vertical engine, very frequently of the two-stroke type. Some of these machines hardly differ from the motor cycles of a dozen years ago in general appearance, although the mudguards are more ample and minor improvements are visible. The simplest of these machines can be obtained for less than 40*l.*, which, taking current prices into account, compares very favourably with the cost of pre-war machines. Indeed, if one studies the prices generally it is clear that no charge of profiteering can fairly be made against the industry.

Among the very light machines the McKenzie designed and sold by Mr. George McKenzie, of 80, Fenchurch-street, E.C. 3, is specially noticeable. It is fitted with a two-stroke engine, with a bore and stroke, both of 60 mm., and rated at 1½ h.p. The frame is only slightly modified from that of a push cycle, the usual down tube from the steering pillar to the crank bracket being curved downwards to form a seating to which the engine can be clipped. The usual horizontal top bar of the frame is bent downwards a short distance from the steering pillar and meets the seat pillar about two-thirds of the way down from the saddle. This enables the machine to be ridden by ladies. The tank, located under the horizontal portion of the the top bar, holds 5½ pints of petrol and 1½ pints of oil. Lubrication is effected by mixing the lubricating oil with the petrol in the tank when the latter is filled, in the proportion of 1 to 12, a measure for oil being provided with the machine. This practice has been found quite satisfactory for these little engines, and it avoids the necessity of paying any attention to lubrication when on the road. The engine has a chain-driven Fellows magneto and an Amac carburettor. The drive to the back wheel is by means of a ¾-in. Dunlop belt, and the ordinary pedalling gear is fitted. Spring forks are fitted to the front wheel. The machine is built by the Hobart Cycle Company, Limited, Coventry, and as will have been gathered, it is constructed on recognised motor-cycle lines. Yet its weight is only 75 lb., and the selling price only 26 guineas. We were assured that it would carry a 12-stone rider up a gradient of 1 in 12 without pedal assistance, and that it had done the London to Exeter journey in a day, with a petrol consumption of 164 miles to the gallon. As a genuine effort to bring motor cycling within the reach of riders of limited means, the future of the McKenzie machine will be watched with interest.

Another lightweight is the 2-h.p. "J. E. S." made by Mr. J. E. Smith, of Gloucester. This also has a two-stroke engine with magneto, spring forks and bell drive. It weighs 100 lb., and is listed at the price of 38*l.* The Excelsior Motor Company, Limited, of King's-road, Tyseley, Birmingham, the Wulfruna Engineering Company, Limited, Brick-kiln-street, Wolverhampton, and other firms, show similar machines at about the same price. In nearly all cases a two-speed gear and kick-starter can be fitted at a small additional cost. When one considers that machines of this type are good for any speed up to 60 m.p.h. and will run well over 100 miles per gallon of petrol, it is clear that motor cycling constitutes about the cheapest and most rapid means of transport in the country. One of the earliest of the lightweights was the Douglas 2¾-h.p., of which 25,000 were supplied to the Government during the war. This machine has always been conspicuous on the roads on account of its "flat twin" engine and outside flywheel. The two cylinders, each 60·8 mm. bore by 60 mm. stroke, are horizontally opposed, and each drives its own crank-pin. Fitted with two-speed gear it will do anything that a reasonable rider will require. It has averaged over 60 m.p.h. during a continuous 6-hour track test, finishing the last 10 laps at an average speed of 67 m.p.h. Its weight is 175 lb., and it is listed at 75*l.* The makers, Messrs. Douglas Motors, Limited, of Kingswood, near Bristol, are also showing a 6-h.p. model, constructed on generally similar lines. This is guaranteed to attain a speed of 80 m.p.h. as a solo machine, and to pull a side-car at 60 m.p.h. It can also be driven so slowly as 4 m.p.h. when necessary. It weighs 425 lb. and costs 165*l.*

The lightweights merge into what may be called the standard roadster class, which embraces machines from 3 h.p. to 4½ h.p., and costing anything from about 85*l.* to 110*l.* The usual equipment of such a machine would be a single-cylinder four-stroke engine, with chain drive to a three-speed gear-box and rubber belt transmission to the back wheel. A kick-starter and engine clutch would be provided as a matter of course, as also would front spring forks. Machines of this power would cover any possible requirement of the solo rider and would take a side-car over most roads with ample power in hand. As practically every maker turns out machines of this kind, it is somewhat invidious to single out any particular firm for mention, but the 4½-h.p. Quadrant, the 4¼-h.p. Abingdon King Dick, the 3½-h.p. Rudge-Whitworth, and the 3½-h.p. Triumph are typical of the class to which we refer. Some of these use a chain instead of a belt for the final transmission, and it appears likely that full chain transmission will soon become universal except for lightweight machines.

So far as power and luxury are concerned, the highest development of the motor cycle is seen in the heavy side-car combinations. For these the Vee twin engine of 6 h.p. to 8 h.p. is practically universal and a three-speed gear-box, kick-starter and clutch, with all-chain transmission are also standard practice. The motor cycle alone will cost anything up to 150*l.*, and the side-car probably another 30*l.*, so that the combination is really coming into competition with the lighter cars. Many persons, however, will prefer an expensive motor cycle to a cheap car and the modern side-cars, with doors, wind screens, collapsible hoods, &c., are so luxurious that the average comfort of the passengers is probably as great in the motor cycle combination as in the light car. A heavy motor cycle and side-car will do 60 miles or 70 miles to the gallon of petrol, and it is as fast as anything on the road, excepting a motor cycle by itself. These features count for a good deal, and in spite of the somewhat unmechanical nature of the combination, it has proved as safe and reliable as any light car. There are several of the latter to be seen at Olympia, a favourite design having a twin Vee engine in front, either air or water-cooled, with a chain drive from a gear-box amidships to a single road wheel at the back. The exhibition closes to-morrow, and it is well worth visiting by all who are interested in the lighter classes of motor vehicles.

BRITISH RAILWAY STATISTICS.

It will be remembered that by the Ministry of Transport Act of 1919 the railways of the United Kingdom were required to furnish to the Minister statistics and returns for which he might call "for the purpose of his powers and duties." The effect has been prodigious. Since the beginning of 1920 we have had four-weekly statements of the behaviour of the companies, while recently the annual returns of capital, working expenditure, &c., have appeared in the form of a bulky blue book of 280 pages. To judge of the amount of work now involved in satisfying the Ministry of Transport's craving for returns, it should be noted that the present compare with returns aggregating about 98 pages in the more modest Board of Trade days, while the humble sum of 1*s.* 3*d.* which they cost in pre-war days increased to 3*s.* for the 1919 returns, and has now risen in the case of the last volume to no less than 10*s.* We honestly do not think such copious records need to be published every year of our railways, and although the transformation was brought about by Sir Eric Geddes, late Minister of Transport, the matter might well receive his now-disinterested attention as Chairman of the Economy Committee on Expenditure, with a view to curtailing expenses which are not only departmental, but national, as very heavy non-production costs to the railway companies are also involved. Are we nationally, after all, so much better off with these elaborated returns?

In our issue of May 6 last (page 558, vol. cxi) we discussed briefly the preliminary returns issued about that time. These were necessarily condensed, and in some respects approximate. The total capital expenditure on the railways of the United Kingdom stood, at the end of 1920, at 1208·2 millions sterling. This was 5·3 millions above the figure for 1919. The amount spent in the year, went mostly in capital expenditure on the railways proper, 2·8 millions; steamboats and marine workshops, 1·8 millions; horses and road vehicles, 200,000*l.*; docks, harbours and wharves, 300,000*l.* The year 1920 was unfortunately like the present one, a very unsettled period for the railways. The industrial situation was unstable; the earning powers of the railways were for a good part of the time still restricted. The changes introduced during the year, and the state of affairs which has held in the last twelve months means that it will be at the earliest in the figures for 1922 that we may hope for really representative data. In 1920 no less than six important changes in rates were made which vitiate comparisons with previous returns, while the industrial situation was so far from normal that the figures cannot be taken as true averages for the country at its best. In 1920 the first increase in freight rates (in the old Board of Trade days "goods" rates and traffic were spoken of) came into force in January, with an all-round increase averaging about 50 per cent. The next increase was in August and affected ordinary fares bringing them up to 75 per cent. above pre-

war level. A coincident increase in "seasons" likewise took effect, bringing them up to 50 per cent. above pre-war level. In the following month a further increase was made in freight rates, bringing them up to about 112 per cent. above pre-war level, while workmen's fares also underwent revision in an upward direction. Later in the same month there was a general increase on the London railways. Increases will also be remembered in connection with demurrage, &c., bringing them up to 150 per cent. above pre-war level.

The gross earnings, excluding Government compensation, amounted to 267,414,000*l.* and the expenditure to 261,755,000*l.*, leaving a balance of receipts of 5,659,000*l.* To this was added miscellaneous receipts amounting to 4,264,000*l.*, which with net Government compensation, gave a total net income of 53,012,000*l.*: this was 58,000*l.* less than the amount returned for 1919.

The standard gauge systems were extended during the year by some 84 miles of line reduced to single track. This was accounted for by additional siding accommodation equivalent to 45 miles, the balance being in running lines, made up of 6 miles of new first track, 16 miles of doubling, 8 miles of third track put down, and 9 miles of fourth, or over. The increase in less than standard gauge lines only amounted to 5 miles. The returns cover 20,156 (route) miles of standard gauge, 2,896 miles of 5 ft. 3 in., 547 miles of 3 ft. gauge, 62 miles of 1 ft. 11½ in., and a few miles each of eight other gauges.

Like 1919, 1920 proved to be to the railways a period of endeavour to overtake war-delayed repairs, &c. Even at the end of the year the Great Western and London and North Western still had 58 locomotives not returned from overseas, but the number of wagons so stranded had been reduced considerably in the twelve months and only numbered 767 at the close of 1920. The total number of steam locomotives on the standard gauge lines increased by 223 in the year, but electric locomotives decreased by five. Coaching stock decreased by over 500 vehicles. The seating capacity, however, showed an increase, for though the steam stock shrank by 3,627 seats, electric stock showed an increase of 5,543 seats, this class of accommodation being, of course, likely to show a continued expansion during the current year, an account of the introduction of new stock on the London railways.

As regards wagons, &c., while there is a small decrease in the number of vehicles of over 20 tons capacity, the classes of 8–12 tons, and 12–20 tons show a considerable increase, while those under 8 tons show a material decrease. The indications of a slow but steady tendency to work with larger wagons to which we lately referred are thus supported. While the year 1920 witnessed only comparatively small registrations of new private owners' wagons, the figure of 7,217 put into service compared with 1,627 for 1919, and 2,414 in 1918. In pre-war years, however, the figure was up to 17,000–19,000. A table classifying the new private owners' stock shows that by far the greater number of these wagons were of 12-ton capacity (5,470 out of 7,217) while 906 were of 10 tons. The balance was mainly composed of 374 tank wagons of 14 tons, 329 20 and 21-ton wagons for brick, lime stone and other traffic, and 62 20-ton wagons for coal and coke.

The year 1920 showed the considerable increase in train mileage of 29,119,399 on the figure of 346,654,198 for 1919, and an increase of 9,602,212 in shunting mileage, while nearly 4,000,000 miles of additional assisting, light running, &c., are recorded. Of the increase in train mileage, about five-sixths of the increase were in coaching traffic, while of the increase in shunting eight-ninths were connected with freight work. At the time the summary was issued we touched upon the general points of the passenger statistics. The new returns give for the first time figures for net ton-miles, wagon miles, engine hours, &c. The net ton-miles per engine hour averages out at 419·98, but the returns show one or two extraordinary departures from the mean such as the Great Western and Great Central Joint Committee which records 1,538 net ton-miles per engine hour, the reason in this case being of course due to through trains with little or no shunting. The measure of ton-miles per route mile per working day gives an indication of density of traffic and the manner in which it is taken over the line. On this basis the Midland, with train loading above the average, and almost the longest average haul for general merchandise in the country, stands first with 6,500 ton-miles per route mile per working day, the average haul for general merchandise being 72·35 miles on this system.

The Barry system, with its intensive coal traffic, comes next with 5,865 ton-miles per route mile per working day. The average length of haul of coal on this line is only 15·41 miles, while the average of England and Wales is 47·43 miles, the longest haul of coal occurring not unnaturally on the Great Eastern, with 80·26 miles, while in Scotland it goes up to 126 miles on the Highland system. These figures, though interesting, only mean that the latter districts are far from the mines. However, there is a lot of coal traffic which is commonly hauled a longer distance than is thus indicated. A good deal of coal traffic originating, for instance, on the North Eastern Railway finds its way to London, but the returns afford no indication of average combined hauls of this character, and are therefore liable to be somewhat misleading, though in the averages for the whole country such traffic is only counted once, and the average for the country is therefore approximately correct. It was, for instance, lately stated in our hearing that as the average haul for coal was only about 47 miles we could not here hope to carry this traffic economically in large trains of high capacity stock. Anyone who advocated such working for the average coal traffic of the country would naturally meet with rebuffs. But for selected point to point traffic, in some cases with long leads, and in others with short, there are indications that high capacity stock might be beneficially introduced with a little more co-operation between the parties concerned.

The average train load works out at 132¼ tons for Great Britain, which is nothing very great, of course, but includes empties and pick-up goods and all the miscellaneous traffic. The best figure for 1920, apart from 179 tons on the short Great Western and Great Central Joint line, is 169¾ tons for the Great Central. The North Eastern Railway, which has made such efforts by means of organisation and advanced statistics, to improve its train working, has only 153·58 tons to its credit, this being exceeded even by some lines which before ton-mile statistics were enforced, were considered to be by no means up-to-date in their methods. It is interesting to note now that these figures are actually available that the model line has not been quite so far advanced in its practice as was at one time imagined. It is practically certain, as this is the first year for which the ton-miles figures are given, that the other systems could not have introduced great reforms promptly enough to affect their averages for the year to any considerable degree, and it may be taken, therefore, that the ton-mile school, reared on the North Eastern, and nurtured in the Ministry of Transport, has rather overdrawn the case for these figures. We have long advocated their introduction, but at the same time we considered that the companies knew better what the effect of their working was than they were given credit for. The present figures prove this, we think, in quite a convincing manner, for the one system that has hitherto used the ton-mile now shows up no better than the many which did not, and from several points of view, perhaps not quite so well.

As motor transport is a live point just now, it may be noted that the railways own only 821 motor vehicles, but nearly 34,000 horse vehicles, engaged in the handling of goods. The majority of these vehicles are engaged on short distance delivery work, for which the horsed vehicle is not easy to beat. The advantages of the motor vehicle, however, have been proved by large departmental stores whose delivery traffic is very similar, but in these cases the services need not necessarily be self-supporting as they are partly advertisement. It is nevertheless rather surprising that mechanical transport does not make further headway with the companies, apart altogether from the question of general road transport. According to the returns the goods motor vehicles of the railways are run at a loss of 32,403*l.*, but there is nothing to guide one as to the direction in which this loss occurred.

Germane to this question is the amount of money in which the railways are mulcted by way of rates. The sum amounted to no less than 9,625,570*l.* in 1920, compared with 6,896,118*l.* in 1919. Our contemporary, the *Railway Gazette*, has recently gone to the trouble of analysing some of these levies, which, in certain cases, amount to no less than 80, 90 and even 91 per cent. of the total rates levied in the parish. We agree that in view of motor competition on the roads, such abnormally high rating of railways, which bring an enhancement of values to all districts they open up, urgently demands revision, and it is to be hoped that their appeals will be successful.

MOTOR ARRANGEMENTS FOR ELECTRIC SHIP DRIVES.

THE electrically-driven ship appears to be establishing a place for itself, particularly in America, while in the case of the San Benito an important example has recently been completed at Belfast by Messrs. Workman, Clark. In these circumstances the electrical features of such ships are probably worth more attention from electrical engineers in general than they have yet received. A ship may be propelled by means of a squirrel cage motor, an induction motor with a wound secondary, or a synchronous motor. Something may be said for each of these various methods, and the finally best arrangement for any particular type of service is hardly yet established. To confine consideration to these three types of motor only is, of course, to neglect direct-current, which can be, and has been, used. For turbine drives, however, which have so far been adopted for the more important installations, alternating current offers advantages, and for the moment attention may be confined to it. Of the three United States electric battleships which are in service the New Mexico has motors with a double squirrel-cage rotor winding, the Tennessee has motors with a form-wound rotor, with external starting and manœuvring resistances, and the Maryland has motors with combined squirrel-cage and form-wound rotors. The fitting of various arrangements to these important ships is obviously a wise policy, and experience gained with them should assist in determining the best all-round system for battleship work.

An interesting consideration of the qualifications of the various forms of motor for ship propulsion generally is contained in a paper read by Mr. W. E. Thau before the Society of Naval Architects and Marine Engineers at the New York meeting the week before last. In addition to the alternating-current arrangements we have considered, Mr. Thau also put forward an arrangement with induction motors having wound secondaries worked in conjunction with a system of power-factor correction. It is not clear if this system has ever been employed, but assuming one is prepared to accept the extra moving machinery involved in the phase advancer, which is not a complicated feature in itself, then the system has the advantage of the unity power-factor of the synchronous motor coupled with the simplicity of and the torque characteristics of the wound secondary induction motor. At the same time synchronous operation is not demanded. The straightforward squirrel cage and wound secondary arrangements have the advantage of simplicity and ease of handling. The torque characteristics of the wound rotor are, however, the better of the two, and the chief claims of the simple squirrel case is that it is robust and inexpensive. By incorporating a double secondary winding as in the case of the New Mexico the torque characteristics are improved.

Direct current in its convenience of control has considerable advantage for ship driving, but difficulties are met at the generating end with a turbine drive. When, however, the generator is driven by a Diesel engine the advantages of direct current are leading to its adoption. The Diesel electric ship is at present the subject of a good deal of attention and a number are being built. It is interesting

to note that Mr. Thau claims the Diesel electric drive to be the cheapest of all. As compared with the direct Diesel drive the engines do not require to be fitted for reversing. Mr. Thau's main argument in this connection appears to turn, however, on the fact that the relatively small Diesel engines and generators fitted to electric ships can be manufactured on a production basis and more or less bought out of stock, while the direct-drive Diesel will have to be built for its job. There is possibly something in this, but the development of the direct-drive Diesel will also ultimately lead to standard and cheaper types. Some real data on the subject would be of interest. Mr. Thau would appear to be in favour of the Diesel-electric ship generally, and he claims it requires less *personelle* to drive it than a direct-connected Diesel equipment.

NOTES.

The Art of the Blacksmith.

In the course of an address he delivered on Wednesday to the Worshipful Company of Blacksmiths, Sir William Ellis stated that the art of the blacksmith might be described as the power of forging and shaping iron or steel from ingots or bars in a heated condition, to form articles of definite shape and dimensions for a wide variety of purposes. The requirements in this direction, he added, extended far beyond what was ever thought of when the blacksmith's industry—probably the oldest industry—came into existence. Sir William gave as instances of modern developments, the supersession of iron by steel, and the present-day forging of heavy marine steel crankshafts and of steel tubes for large calibre guns. He also referred to the welding of heavy iron links for the manufacture of marine chains and cables, a trade requiring very conscientious work on the part of the smiths, this being one of the few examples of manual effort in which a few minutes of careless work might involve most serious consequences. According to Sir William, the thoroughly equipped blacksmith to-day could only be represented by a man who had carefully studied metallurgical questions—forging temperatures, quenching temperatures and media, heat treatment; such knowledge enabled him to succeed in the highest branches of his work. Owing to the modern use of forging presses, the blacksmith, or forgeman, besides a metallurgical training, had also to have a very high engineering training. In looking at different manual trades, such as that of the fitter, the moulder, the patternmaker, and many others, and comparing them with the blacksmith's trade, Sir William found an essential difference in that the blacksmith depended upon his personal skill and the exactness of his eye much more than the workmen who had specialised in other crafts. We fully admit that the more educated a man is in the subjects which concern his trade the better, but we were not aware that the successful, present-day blacksmiths—difficult though their work be—were possessed of any very high training in metallurgy and engineering. We know that they depend upon the exactness of the eye, and in this respect blacksmiths, as also steelmakers when judging the working of a steel bath, reach a very remarkable degree of accuracy, so much so in fact that, according to our experience, they are apt to disdain rather than desire the assistance which scientists are able to place at their disposal.

Effect of Cold Work on Cadmium.

Matthiessen and von Bose observed in 1862 that cadmium turned brittle when heated to 80 deg. C., and that its electric conductivity was much reduced; the particulars of these experiments, however, were not published. When E. Cohen and W. D. Helderman, of Utrecht, in their search for allotropic modifications of metals, experimented with cadmium in 1914, they heated the metal in an atmosphere of carbon dioxide or in diluted solutions of cadmium sulphate, and they made later also experiments in galvanic cadmium cells. They concluded that cadmium occurs in two (possibly three) modifications, Cd α turning into Cd β at 64·9 deg. C., and that the properties of cadmium hence required redetermination. As one can hardly expect cadmium to remain unchanged when heated for 24 hours under the conditions stated, it is interesting that Mr. J. Neill Greenwood, M.Sc., of Sheffield, in a paper read last Monday before the Faraday Society, confirmed the probability of allotropic changes by purely mechanical tests. Mr. Greenwood noticed that pure commercial cadmium, containing only 0·25 per cent. of lead and no zinc, behaved erratically in Brinell tests. He first observed that the metal, slightly hammered to remove local irregularities and then annealed at 100 deg. C., became softer in the course of 100 hours in the portions which had been submitted to the cold work. Brinell tests of, chilled castings, ½ in. thick, deformed by hammering gave a hardness of 21·4 in the worked condition against 23·4 in the unworked metal as cast. In six days the hardness further decreased to 19·45, whilst the original metal did not appear to change. Further experiments proved, however, that chilled castings of cadmium do gradually soften a little in the course of a week or two, even when not worked in any way. This behaviour is exceptional. Whilst the hardness of cadmium was decreased by 10 per cent. by cold work and by 10 per cent. more on standing, aluminium increased its hardness by 37·5 per cent., magnesium by 43 per cent., and tin by 29 per cent. when hammered; in all these metals, however, the hardness subsequently diminished, though only slightly. In his metallographic tests Mr. Greenwood etched the specimens with nitric and chromic acids, and he found that the cold work merely of polishing the specimen with chamois leather was sufficient to hasten the recrystallisation and softening of the metal. He therefore cast pellets on a polished plate. At 20 deg. C. the spontaneous recrystallisation, which was most rapid in the initial stages, seemed to be completed in 12 days. Heating experiments showed a decided change in hardness near 60 deg. C. Mr. Greenwood therefore assumes with Cohen and Smits that there are two modifications of cadmium, mutually soluble in one another until a critical state of crystallisation has been set up, and that Cd α is stable between 20 deg. and 60 deg. C., and Cd β between 65 deg. and 140 deg. C.

Mining During the War.

On Thursday afternoon, November 24, Field-Marshal Lord Haig unveiled at Cleveland House, City-road, the present joint home of the Institution of Mining and Metallurgy and the Institution of Mining Engineers, two war memorials to the members of these institutions who fell during the war. Mr. F. W. Harbord, president of the Institution of Mining and Metallurgy, and Colonel W. C. Blackett, past-president of the Institution of Mining (speaking in the absence in the United States of Sir John Cadman, the president of the latter institution), welcomed Lord Haig and expressed to him their gratitude for his having consented to undertake the ceremony. In the course of his speech, Lord Haig said he was glad in having the opportunity of speaking a few words of special thanks to a body of men whose work at the front, although it had not drawn upon itself much notice, had been surpassed by none in the demands it made upon the individual concerned and in the service it rendered to the Army as a whole. He recalled the battle of Messines and spoke of the mighty series of explosions which tore great gaps in the German lines on June 7, 1917, giving the signal for one of the most successful of our attacks. That was the result of the work of one of the special services to which the two Institutions gave so many gallant soldiers, a work which formed the crown of British mining in war. Few outside those who actually took part in that work and those who benefited by its results could realise the vast amount of study and of persistent toil carried out in every circumstance of peril which might well appal the stoutest heart, that went to the preparation of that triumph. There was no truce at any time for the warfare that went on underground, no rest in the men's toil; on the contrary, periods of redoubled activity were constant, for every offensive meant a fresh call on the industry, the energy and courage of the miners. An immense amount of similar work was also done on the Somme, and the underground preparations for the battle of Arras attracted little attention compared with those at Messines, but they were no less valuable. Later, also, when the day of elaborately-prepared attacks was over, the tunnelling companies found a work hardly less arduous and dangerous in the discovery and the removal of many thousands of German mines. The men whose memory they had met to honour had died nobly in doing their duty, and Lord Haig was glad of the opportunity of thanking them on behalf of the whole Army. The unveiling of the memorials was followed by a silence of one minute; Lord Haig then pronounced the words, "Their name liveth for evermore," then the "Last Post" and the "Réveillé" were sounded by trumpeters of the Honourable Artillery Company. The names on the Roll of Honour of the Institution of Mining and Metallurgy number 126, and on that of the Institution of Mining Engineers 77. The Councils of both institutions hope that the relatives of these fallen members will visit Cleveland House in order to see the memorials.

ENGINEERING SCHEMES IN PARLIAMENT.

The credit which would have furnished the means for further developing the natural resources of the country was expended during the period of the great war in providing the munitions dissipated on the fields of Flanders and elsewhere, so that it is not surprising that the engineering schemes for which sanction will be sought next session are few in number and almost wholly lacking in distinction. Apart altogether from the prevailing financial stringency hesitancy is commendable on the part of railway companies until the new groups have been formed; but later the claims of electricity will have consideration.

Railways.

Notice is given that a preliminary scheme for the amalgamation of the Lancashire and Yorkshire Railway with the London and North-Western has been submitted to the Ministry of Transport for reference to the Railways Amalgamation Tribunal. The Midland Railway, as mentioned elsewhere, is promoting a Bill for improvements in the harbour accommodation at Tilbury, but none of the great English lines is appealing to Parliament for powers to undertake important new railway work. The North-Western and Midland group, which includes the London and North-Western, the Lancashire and Yorkshire, the North Staffordshire and the Furness undertakings is, however, promoting a Bill empowering the companies in question to operate motor road vehicles. In Scotland the Caledonian, the Glasgow and South-Western, and the Highland Railways constituting the West Scottish Group, are also seeking power to run motor road vehicles for freight and passengers. The Caledonian Company, moreover, seek sanction and confirmation of a deviation already constructed of their Crieff branch at Blackford. In the Manchester area, the Trafford Park Company propose the construction of (in all) about ½ mile of new dock lines.

Tramways and Light Railways.

The Ashover Light Railway Company are applying for powers to construct a light line of 2-ft. gauge from the Clay Cross Company's works at Woodthorpe to Stretton, where a junction will be made with their No. 1 line authorised in 1919, of which it is proposed to alter the gauge. Lines of 2-ft. gauge were largely used for war service in France, and the suggestion was made shortly after the armistice that the plant and rolling-stock might provide a cheap method of transport in country districts here. Possibly the above scheme is an outcome of this proposal. In view of the claims often made for canal transport it is not a little significant that only Canal Bills to be brought before Parliament will authorise the abandonment of existing canals.

Tramways and Motor Omnibuses.

Rather more tramway activity is forecasted than might have been anticipated, in view of the many drawbacks attached to this type of urban transport. Thus the Glasgow Corporation propose the construction of about 7 miles

of new line, and in view of the obstruction to other traffic now attending the circulation of their cumbrous cars, it is a little startling that they propose to make matters worse by taking powers to attach trailers to them. The Corporation also ask permission to run motor 'bus services along various routes into the country surrounding their city. The London County Council seek sanction for a new line from the Seven Sisters Road along the Amhurst Park Road to Clapton Common with a branch to Stamford Hill. Their most interesting proposal is, however, for a trolley service from West Norwood to Lee Green. The Birmingham and Bristol Corporations are local authorities inclined to speculate in trolley 'bus services. At Nottingham a new tram line through Heanor to Shepley and Ilkeston is proposed, whilst about 2¼ miles of new line are proposed by the Bristol Corporation. The Aberdeen Corporation proposes to lay nearly 2 miles of new track, whilst that of Ayr is to double certain of the existing lines. In England the Corporation of Morecambe have in view a further extension of their tracks, and Blackburn is seeking similar sanction. Corporations seeking powers to run motor 'bus services are those of Aberdeen, Ayr, Bolton, Doncaster, Jarrow and Northampton.

Electricity.

Almost the only Bill of interest is that promoted for the construction of a hydro-electric power station on the River Garry at Blair Athol, and to increase and regulate the water available by enlarging Loch Rannoch, Loch Ericht, Loch-an-Duin, Loch Garry, Loch Mhaire, and by constructing in addition a reservoir across the River Tummel at Fortingall, and across the Bruar River at Blair Athol. The natural flow to the various lochs and reservoirs will be augmented by a series of catch-water aqueducts. The whole of the works will be situated in the counties of Perth and Inverness. It is understood that the scheme is the first instalment of a project for utilising the whole of the mountainous area in Scotland for power production. In view of the fact that water power is almost a *sine qua non* for the successful prosecution of a number of important industries, it is to be hoped that the legislature will look on the scheme with a benevolent eye.

Another hydro-electric power scheme is that proposed by the Corporation of Ayr. Their plans involve an enlargement of Loch Doon, with a power station on the River Doon at Dalmellington.

In the London area, sanction is sought for the transfer to the North Metropolitan Electric Power Supply Company of the undertakings of the North Metropolitan Electricity Distribution Company. Other clauses in the Bill sanction the purchase of current from the Metropolitan Railway and from the London and North-Western Railway. This Bill may possibly conflict with a Bill which is being brought in to make provision for facilitating the carrying into execution of any scheme which the Electricity Commissioners may approve under the Electricity (Supply) Act, 1919, constituting as a separate electricity district the whole or any part of the area comprised within and being the counties of London (including the City of London), Middlesex, Berks, Buckingham, Essex, Hertford, Kent and Surrey (including the county boroughs of East Ham, West Ham and Croydon). A Provisional Order for the Burgh of Crieff is sought by the local authority.

Harbours, Docks and Piers.

The most important proposal in the matter of dock improvements is a scheme backed by the Port of London Authority and the Midland Railway for the construction at Tilbury of a floating stage, 2,000 ft. long and 80 ft. wide. The Bill also seeks sanction for 900 ft. of new river wall and platform. The project for constructing a deep water wharf on the north of Canvey Island, near Haven Hole Coastguard Station, is revived. The promoters seek railway connections at Pitsea with the Barking and Southend line, and with the Tilbury and Pitsea line; whilst connection with the Great Eastern metals is to be made near Fanton junction. Incidentally a motor road from Pitsea to Canvey Island is included in the plans. The River Wear Commissioners propose some extensive improvements near the south outlet from Sunderland Docks. The Poole Harbour Commissioners propose the construction near South Haven Point of 3,600 yards of new training bank. In Scotland, the town council of Portknockie propose fairly extensive additions to their quay space and to extend somewhat the existing jetty.

Street Widenings and Bridge Work.

There are far fewer proposals for street widenings and improvements than might have been expected, in view of the ever-increasing importance of road transport. No doubt the difficulty of financing such an expensive class of work is causing public authorities to move somewhat slowly in the matter. In the City of London the corporation propose to widen Lamb-street and Spital-square on the south side for a distance of 90 yards, and to construct a new street from Spital-square to the junction of Steward-street and Brushfield-street, and the latter is to be widened for 115 yards on the North side. Others proposing work of this character include the Corporations of Ayr, Bolton, Jarrow, Padiham and Glasgow. The Corporation of Hull seek sanction for a new opening bridge over the River Hull in substitution for the existing North Bridge, a fixed structure, which is to be removed. The pipe lines and mains which now pass over this bridge are to be carried underneath the river in a tunnel. The Cambridge Corporation propose to construct two new bridges over the Cam. Of these, one will be a footbridge only and will be situated near De Freville-crescent, whilst the other will be a road bridge at Abbey-road.

Water Supply.

The extraordinary drought we experienced during the past summer seems to have found our cities and towns reasonably well secured against a really serious water famine. At any rate no very large amount of new work is in prospect. The Halifax Corporation, however, propose the construction of two new reservoirs, on the Reaps Water to be known respectively as the Upper and Lower Gorple Reservoirs. The scheme includes extensive catch-water channels to divert into them drainage now passing elsewhere. Works of a minor character generally comprising new wells, pumping stations and storage tanks are to be undertaken at Northampton, Ramsgate, Newhaven, Worthing and Colne Valley. The Birmingham Corporation propose to replace their service reservoir at Frankley with one of greater capacity. The Bristol Corporation have a scheme for enlarging their Netham reservoir by raising the height of the existing dam. In Ayrshire the local authority at Girvan proposes to construct a reservoir on the Penwhapple Burn and its tributary stream at Dailly. The new works will include two break-pressure tanks and a set of filters. The Durham County Water Board seek to construct a new reservoir in substitution for the Burnhope reservoir sanctioned in 1915. The new work will involve the damming of the Burnhope Burn near Burnhope Bridge. There will be a break-pressure tank at Stanhope and another in the urban district of Brandon and Byshottles. The Sunderland and South Shields Water Company are applying for powers to construct a new reservoir at Mill Hill, Easington, and another at Stoney Gate. The Bolton Corporation seek sanction for sinking five new wells and for the construction of three new service reservoirs. The local authority of Padiham (Lancashire) are asking powers for the enlargement of their Churn Clough reservoir, to divert into it more of the natural drainage. A new pumping station on the Pildacre estate is proposed by the Corporation of Ossett, in addition to a water tower near their Gawthorpe reservoir. At Shepton Mallet it is proposed to construct a new tank at Beacon Hill.

Gas.

The gas Bills are without interest, being for the most part proposals to substitute a calorific for an illumination standard. There are also numerous proposals to lower the calorific value to well below 500 B.Th.U. per cubic foot. In one case the value proposed is as little as 425 B.Th.U. per cubic foot. The ultimate result should be a considerable reduction in the price of gas per therm. One local authority, viz., that of Neath, seek powers to supply fuel gas.

LITERATURE.

History of the Great War, Based on Official Documents. By Direction of the Historical Section of the Committee of Imperial Defence. Naval Operations. Vol. II. By Sir JULIAN S. CORBETT. London: Longmans, Green and Co. 1921. [Price 21s. net.]

THE second volume of the authoritative work of Sir Julian Corbett on the naval operations during the European War embraces the months from November, 1914, to May in the following year, covering the period which included the raid on the Yorkshire coast, the Dogger Bank action, and the opening of the Dardanelles Campaign, which overshadowed in its dramatic interest, as in its political significance, all other episodes. There were other events of less moment on which we may look back with feelings of satisfaction, in so far as the nation exhibited unflinching heroism in the face of gathering disaster, but few can be regarded with pride as evidencing the nation's superiority in naval and military tactics. Exception may be made in favour of the suppression of commerce raiders, though here contradictory orders from the Admiralty, hindered, rather than assisted in aiding the discovery of the hiding place of the Dresden, and in the words of the author "afforded a striking instance of the danger of taking such operations out of the hands of the men on the spot, who have the best means of sifting local intelligence." The work was done and effectively, and never in the history of our wars have the seas been so quickly cleared of commerce destroyers, while the percentage of damage inflicted on our commerce was comparatively trifling. Possibly the keenness of the disappointment the enemy must have experienced in making so small an impression on the vast bulk of our seaborne commerce, led him to adopt that form of submarine attack, the disastrous effects of which were destined to surpass all previous methods of destruction and to reach a total so formidable that the losses inflicted by the surface commerce raiders sink into insignificance by comparison.

The raid on the Yorkshire coast culminating in the bombardment of Scarborough and Hartlepool is told with great minuteness, and the position of the units of the fleet can be traced from hour to hour. The more the plans and the description are studied, the more ground is there for the mortification felt at the time at the smallness of the outcome. Two efficient and powerful British squadrons were on the spot with an adequate force of scouting vessels, and the enemy's plans were generally foreseen and counter dispositions prepared, yet we failed to bring the enemy to a conclusive action. Sir J. Corbett will not apportion blame to anyone, for individual judgment must draw its own conclusion on whom responsibility rests when the situation is so full of vague possibilities and indeterminate factors. But he hints that "too much reliance was placed upon the negative evidence as to the quiescence of the High Sea Fleet." In the confident expectation that the raid would be made by cruisers, unsupported by force, Admiral Jellicoe was not moved down in support, "but this in no way affects the merit of his own disposal of our intercepting force." The precise cause of failing to bring the enemy to action is attributed to the movement of Admiral Beatty in turning to the south east, but under the conditions, this manœuvre was in strict accordance with the soundest principles of naval tactics. If the English nation and the English fleet were disappointed at the inconclusive result, the Germans were no less mortified, and as far as one can see with less reason. The Germans recognised that they had a chance of dealing with the two detached squadrons under Admirals Beatty and Warrender, which if it had been seized with ardour and pushed with energy would have resulted in placing the Grand Fleet and the High Sea Fleet nearly on an equality. But Admiral Scheer exaggerated in declaring that the premature turning of the German Fleet to the east-south-east robbed the Germans of the chance of annihilating certain of our divisions. Similarly Von Tirpitz's ejaculation that Ingenohl (the German Admiral in command) "had the fate of Germany in the palm of his hand," was rather a measure of the annoyance he felt than an accurate description of the situation.

If the Dogger Bank action was more conclusive in its results, and the certain loss of the Blücher with severe damage to the Seydlitz and other cruisers declared a British victory, yet the success was not so complete as those engaged had a right to hope. The luck that had favoured the Germans off Scarborough was repeated a second time, offering them a means of escape when defeat was hovering near. It is, too, curious to note, that again a mistaken or illegible signal prevented the plans of the English admiral being carried out in their entirety. The wireless apparatus was out of order on the Lion (Admiral Beatty's flagship) and the old method of flag signalling had to be followed, while unfortunately the direction of the wind blew the flags end on, to the three battle cruisers signalled. This foreshortening coupled with the smoke from the guns prevented the historic signal that Nelson had hoisted at Trafalgar "keep close to the enemy" being accurately apprehended, or being seen at all. The Tiger and the Princess Royal withdrew their attack on the Moltke and the Derfflinger, who retired to the safety of the Heligoland shelter. Those who knew how near was the reward of clear and decisive victory were chagrined by the poor result on paper, but the Germans well knew the severity of the blow that had been struck, and for many a long day they remained in their own waters, not venturing to repeat their idle boast, that the enemy was skulking in port behind a screen of mines, with no wish and no power to assert their claim to supremacy over the North Sea. The German Government issued no official report for several months, "and this long silence, combined with the inaccuracies of the report, told plainly enough how severe had been the moral shock of the encounter."

Many minor incidents which increased the tension of the situation at the time must be passed over. Among these are the Turkish attack on Egypt, in which the Navy and Army effectively co-operated and easily sustained the attack, which being made with inadequate force and inadequate preparation was never within a measurable distance of success. The Cameroons was another theatre that distracted attention and required men and ships to maintain the partial success achieved, while in the South-West of the Continent, the struggle, ultimately successful, was being directed by the able hands of General Botha. There was little to cheer the nation and reward the troops on the West Coast, but in German East Africa, the condition was distinctly unsatisfactory and it was borne in on the directing minds at home, that the strength, the resource, and the preparedness of the enemy had been entirely miscalculated. The Navy had displayed some activity at Dar-es-Salaam, but no material progress had been made, and we know how the defence of the German colony, ably organised and energetically maintained, was destined to keep the British force at bay for years. Another irritating point was the necessity of watching over the Konigsberg, which had taken refuge in the Rufiji River, and the possibility of its escape was a bugbear to the Admiralty, throwing a grave additional burden on the Navy, as the force required was utterly disproportionate to the value of the blockaded ship. At one time, the Germans could enjoy the spectacle of their impotent cruiser holding up a battleship and two light cruisers. Unlike the Dresden, that escaped the Battle of the Falklands, its end is not narrated in this volume.

It is unfortunate that the whole of the history of the Mediterranean Expedition could not be included in this volume, thus preventing a complete view of the causes and consequences of the disaster. Moreover, the tale is brought to a close on a discordant note, in which Lord Fisher and Mr. Churchill are seen withdrawing themselves from the Government when the crisis was at its height and the exhibition of divided counsels particularly regrettable. This division, probably dictated by the growing size of the book, might have been avoided if the author had not devoted so much space to the consideration of purely military topics. But herein we hold the author justified: since the movements of the fleet were determined in a great measure by the policy of the War Office it is hardly possible to have an intelligent conception of the Government policy as a whole, without considering the part played by each branch of the service. Necessarily friction or professional feeling must arise from placing the defensive forces of the realm under two controlling departments, trained in different traditions, and neither appreciating the standpoint of the other. The military view appears to have been that the duty of the naval force was to assist the army, while the Navy expected the army to complete the work which the Navy had begun. Whether this view is correct, or not, it is necessary to have a clear understanding of the guiding motives, if we would decide whether the Gallipoli movement was an unwarrantable gamble or dictated by sound military policy.

At the end of 1914, Sir J. French had elaborated a scheme for employing the whole of the British and Belgian armies in a homogeneous force to be pushed up the Belgian coast, in co-operation with the Navy, with the view of turning the German right. To do this, he wanted large reinforcements, at least 50 battalions of Territorials or the New Army, but even if this force were added, he did not see that ultimate victory could be attained. Only in the East, on the Russian front, could the decision come, but nevertheless, he urged that the whole of our army should be employed in France. The Government, aware of the deadlock, and perceiving the part that defensive tactics would play in Flanders, sought an opportunity to employ the new troops on some independent line of operations, where our command of the sea would give us a great advantage over the Germans. A new field of operations that would assist Russia had also to be considered. The Grand Duke had checked the invasion of Poland before Warsaw, but his own invasion of Galicia had been frustrated and unless he could deal a striking blow in Poland, the promising penetration of Austria could not be resumed. The Grand Duke pressed for a diversion against the Turks, and Lord Kitchener applied to Lord Fisher regarding the possibility of making a successful naval demonstration at the Dardanelles. Lord Fisher was more than doubtful; he could not see that any effective purpose would be served by repeating a bombardment that had already proved its inadequacy. A much larger and differently constituted force would certainly be needed, and a sufficient military force must be available to co-operate with the fleet. This plan would necessitate the diversion of a substantial force from Sir J. French's command, to which he and Joffre would never consent. The ill-success of Joffre at Soissons compelled him, however, to recall some 100,000 troops from the North, and French, deprived of this assistance, saw his plan imperilled if not rendered absolutely impossible.

The French reverse strengthened the hands of the party who were seeking an alternative scheme to make the power of the nation felt, for there appeared no reason at the moment why we should commit ourselves further on French territory, and Sir John was definitely informed that his coastal advance was not approved, and that the reinforcements he needed would not be sent. Apparently this view was supported by Kitchener, who not only entered heartily into the Dardanelles scheme, but over-persuaded the First Lord, who threatened resignation, by urging that such a naval attack as the Dardanelles offered was vitally important, that if successful it would be equivalent to winning a campaign, and that moreover it had the great merit that it could be broken off at any time if progress became unsatisfactory, but to contemplate quitting a scheme before entering upon it hardly seems the best way to bring it to a successful issue. Though it has been asserted that the Navy offered to rush the Dardanelles, it must be clearly understood that this statement is unwarranted. Neither Lord Fisher nor Admiral Carden on the spot would have embarked on the project if there had not been a military force, set free by the course of events in France, sufficient to co-operate in the venture. Particularly after the failure of the great attempt to force the Narrows, the Navy was twitted with their want of foresight in trying to force their way through without providing a force to hold the banks and prevent the closing of the passage behind them. Whatever mistakes may have been made, and they were many, such lack of prevision is not to be charged against the Navy. That somebody blundered cannot be denied, but a scheme born in controversy, pursued with hesitation, and hampered by divided responsibility, was doomed to end in failure. The heroism of individuals, the willing sacrifice of life, the devotion to a lost cause may awaken enthusiasm, but does little to remove the stigma of recklessness from those who projected a perilous scheme without sufficient considera tion, and were prepared to abandon it indifferent to the cost of an abortive attempt.

The worst is not told in this volume, and though Sir Julian leaves off on a sad note, which tells of the increasing activity of German submarines and the loss of the Lusitania, he will have to open his next volume amid still more dismal surroundings, in which it was difficult to see a welcome gleam of hope.

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Untersuchung einer Wagerecht-Stossmaschine mit Elektrischem Einzelantrieb. und Riemenzwischengliedern. Von Dr. Ing G. Schlesinger und Dr. Techn. M. Kurrein. Berlin: Julius Springer. [Price 16 marks.]

Costruzione di Macchine. I. *Elasticità e Resistenza dei Materiali.* Second edition, revised and enlarged. [Price 42 lira.] II. *Organi per il Moto Rotatorio* [Price 16 lira.] III. *Macchine a Stantuffo e Loro Elementi.* Second edition, revised. [Price 42 lira.] IV. *Ingranaggi.* [Price 28 lira.] By Ottorino Pomini. Milano: Ulrico Hoepli.

Fifty Years of Electricity. The Memories of an Electrical Engineer. By J. A. Fleming, M.A., D.Sc., F.R.S. London: The Wireless Press, Limited. [Price 30*s.* net.]

Bleaching. Being a Resumé of the Important Researches on the Industry published during the Years 1908–1920. By S. H. Higgins, M.Sc. Manchester: University Press. London: Longmans, Green and Co. Price 10*s.* 6*d.* net.]

The Decortication of Fibrous Plants. By H. R. Carter. London: John Bale, Sons and Danielsson, Limited. [Price 4*s.* net.]

British Railways and the Great War. Organisation, Efforts, Difficulties and Achievements. Vols. I and II. By EDWIN A. PRATT. London: Selwyn and Blount, Limited. [Price 42*s.* net, 2 Vols.]

Blue Printing and Modern Plan Copying. For the Engineer and Architect, the Draughtsman and the Print Room Operative. By B. J. HALL, M.I.Mech.E. London: Sir Isaac Pitman and Sons, Limited. [Price 6*s.* net.]

Benzine and Mineral Lubricants. Their Production, Testing and Uses. By DR. J. FORMANCK. Revised to date by the author and translated from the German by CHARLES SALTER. London: Scott, Greenwood and Son. [Price 15*s.* net.]

Department of Overseas Trade. Report on the Conditions and Prospects of British Trade in Canada. August, 1921. By Captain E. J. EDWARDS. London, Manchester and Cardiff: His Majesty's Stationery Office. [Price 2*s.* 3*d.* net.]

Department of Overseas Trade. Report on the Trade and Commercial Prospects of East Africa. By Colonel W. H. FRANKLIN, C.B.E., D.S.O. London, Manchester, Cardiff and Edinburgh: His Majesty's Stationery Office. [Price 1*s.* 3*d.* net.]

Der Landstrassenbau. Von A. LIEBMANN. Second edition, revised and enlarged. Berlin and Leipzig: Walter de Gruyter and Co. [Price 2·10 marks plus 100 per cent.]

Thermosbau. Konstruktionsgrundlagen und Anwendungen. Von. H. POHLMANN. Berlin: Julius Springer. [Price 32 marks.]

Lehrbuch der Eisenhüttenkunde. Zweiter Band. *Erzeugung und Eigenschaften des Schmiedebaren Eisens.* Von BERNHARD OSMANN. Leipzig: Wilhelm Englemann. [Price 175 marks, plus 100 per cent.]

Atomic Theories. By F. H. LORING. London: Methuen and Co. [Price 12*s.* 6*d.* net.]

The Westinghouse Air Brake. A Description of the System and its Working. London: The Locomotive Publishing Company, Limited. [Price 2*s.* 6*d.* net.]

Metric System for Engineers. By CHARLES B. CLAPHAM, B.Sc. London: Chapman and Hall, Limited. [Price 12*s.* 6*d.* net.]

Elektrische Fordermaschinen. Von Professor W. PHILIPPI. Leipzig: S. Hirzel.

The Sea Traders. By ARCHIBALD HURD. London: Cassell and Co., Limited. [Price 7*s.* 6*d.* net.]

Canada. Department of the Interior. Topographical Surveys Branch. Bulletin No. 44. *Standardisation of Measures of Length at the Laboratory of the Dominion Land Surveys.* Ottawa: Thomas Mulvey.

Electricity in the Service of Man. A Popular and Practical Treatise on the Applications of Electricity to Modern Life. Vol. II, Section III. *The Technology of Electricity.* By R. MULLINEUX WALMSLEY, D.Sc., F.R.S.E., M.I.E.E. London: Cassell and Co., Limited. [Price 15*s.* net.]

Entropy as a Tangible Conception. An Elementary Treatise on the Physical Aspects of Heat, Entropy and Thermal Inertia. For Designers, Students and Engineers. By S. G. WHEELER, Engineer-Lieutenant Commander R.N. London: Crosby, Lockwood and Son. [Price 8*s.* 6*d.* net.]

The Journal of the Iron and Steel Institute. Vol. CIII, 1921. Edited by GEORGE C. LLOYD. London: Published at the Offices of the Institute.

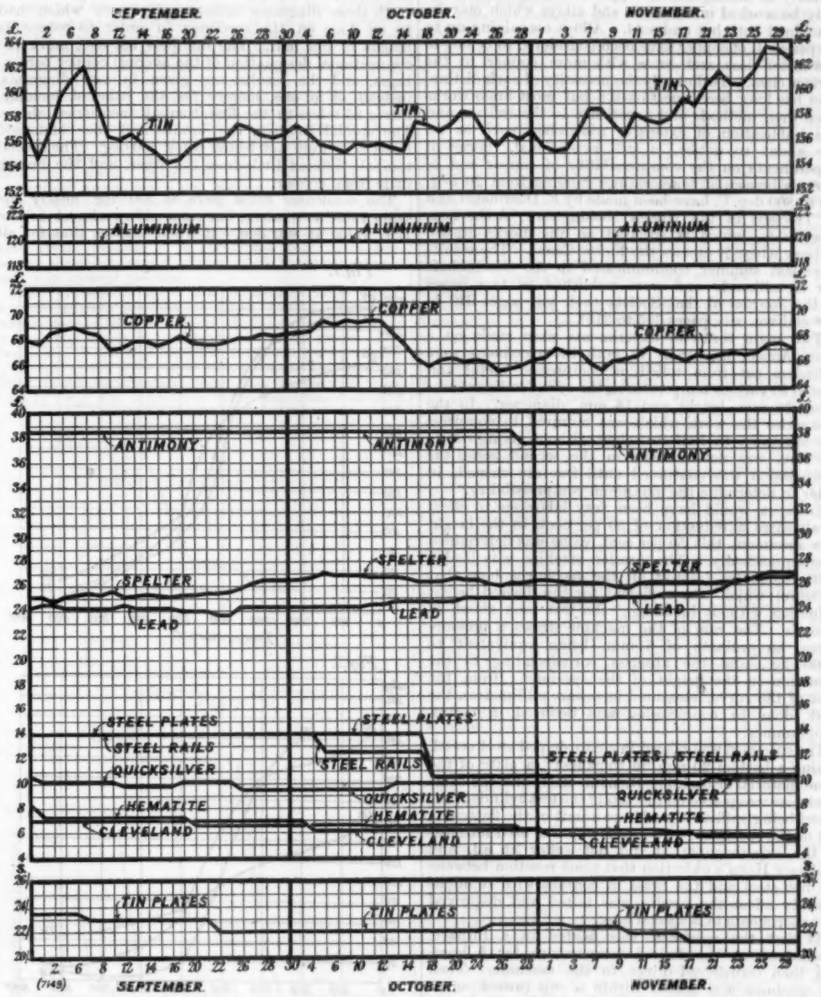
The Transition Spiral and its Introduction to Railway Curves. With Field Exercises in Construction and Alignment. By ARTHUR LOVAT HIGGINS, M.Sc., A.R.C.S., A.M.Inst.C.E. London: Constable and Co. [Price 6*s.* net.]

ROAD TAMPING MACHINE—ERRATUM.—In the description of the tamping machine shown by Messrs. G. Percy Trentham, Limited, of Winchester House, Victoria-square, Birmingham, and 7, Queen-street, Cheapside, E.C. 4, at the recent Public Works Exhibition, and described by us on page 735 of our last issue, the weight of the head was given as 75 lb. This should have read 175 lb. This correction is of importance as the value of the machine largely depends on the weight of the head.

SAFETY PETROL TANKS FOR AIRCRAFT.—The competitive trials of safety tanks for aircraft, which were announced in our issue of August 26 last, on page 323, will be commenced on Monday next at Farnborough, and will thereafter be continued on alternate days until completed. Owing to the importance of the competition it was thrown open to the world and 26 entries in all have been received. Of these, 19 are British and 3 French, and 1 each has been received from America, Belgium, Italy and Japan. The characteristics of the tanks will be considered in the following order: Light weight, durability under service conditions, indifference to extremes of temperature, adaptability of design to large capacities, simplicity of construction, adaptability of design to various shapes, accessibility of fittings and cost of production. All tanks will be submitted to preliminary trials and the three best types will be selected by the judges for a final trial. In the preliminary tests each tank will be mounted in a wooden structure and located behind a concrete body formed to represent an engine. The tank will be released down a guideway 100 ft. high, and arranged so that the structure will strike the ground at an angle of not less than 45 deg. from the horizontal, and will be free to turn over. This arrangement, it is considered, will represent the conditions of a typical aircraft crash as nearly as possible. In the final tests, besides a crashing test similar to that described above, the tanks will be subjected to machine-gun fire at a range of 50 yards. There will, however, be an interval of at least eight weeks between the preliminary and final tests.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal Markets.)



NOTE.—In the diagrams the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given, in the case of steel plates are for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for the East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of tin-plates is per box of I.C. cokes f.o.b. at Welsh ports, but in all other cases the prices are per ton. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each.

THE SWEDISH MERCANTILE MARINE.—We read in *Swedish Export* that the Swedish mercantile marine was increased during September by 16 vessels of 15,700 tons gross. At the close of the month the merchant fleet numbered 1,228 steam vessels of 912,000 tons gross, 643 motor vessels of 144,000 tons gross, and 927 sailing vessels of 106,000 tons gross.

"LITTLE GIANT" ELECTRIC HAMMER.—A new form of electric hammer has been brought out by the Consolidated Pneumatic Tool Company, Limited, of Egyptian House, 170, Piccadilly, W. 1, under the well-known name "Little Giant." The chipping hammer which is suitable for light riveting, chipping, &c., weighs 7 lb. and has an overall length of 13½ in. A smaller hammer for stone working and weighing 5 lb. is also made.

THE STRUCTURE OF GASEOUS MOLECULES.—At the meeting of the Faraday Society to be held in the Rooms of the Chemical Society, Burlington House, W. 1, on Tuesday, December 13, at 8.15 p.m., Professor A. O. Rankine will deliver an address on "The Structure of Gaseous Molecules," which will be followed by a general discussion. Tickets of admission may be obtained from the Secretary, of the Faraday Society, 10, Essex-street, London, W.C. 2. This meeting will be preceded by the annual general meeting, which is fixed for 7.45 p.m.

BOILER PLANT FOR MORWELL POWER STATION.—We are informed that the contract for the supply of 12 Thompson water-tube boilers for the Morwell Electric Power Station of the Victorian Government has just been secured by Messrs. John Thompson Water-Tube Boilers, Limited, of Wolverhampton. The boilers are of the firm's well-known straight vertical tube type, and are each designed for the evaporation of 70,000 lb. of water per hour at a working pressure of 260 lb. per square inch; superheaters will be provided to give the steam a final temperature of 650 deg. F. The boilers will each be fitted with three Underfeed travelling-grate stokers working with forced draught and arranged to burn Morwell brown coal. This coal, it may be mentioned, is found practically on the earth's surface, and the power station is being erected quite close to the deposits. The boilers will be supplied complete with chimneys' flues and automatic soot and ash-extracting and disposal plant. In view of the present industrial situation it is particularly satisfactory to note that this contract has been obtained in face of severe competition from American firms.

COMPRESSIBILITY OF BRASSES AT TEMPERATURES UP TO 800 DEG. C.

ACCORDING to text books two classes of brass may broadly be distinguished, copper-zinc alloys which can only be worked in the cold, and alloys which may be machined both hot and cold. Alloys containing up to 63 per cent. of copper have been considered to belong to the latter class, and brass with more copper to the former class. Technically the necessity of such distinction has long been questioned; but most brass works keep their methods and experience to themselves, and the publication of extensive researches, such as we are about to notice, is still exceptional. Series of experiments on the compressibility of copper and of various brasses at temperatures ranging from 20 deg. up to 800 deg. C. have been made by F. Doerinckel and J. Trockels in the Hirsch Messingwerk, A.G., near Eberwalde, which is situated on the Berlin-Stettin railway where it crosses the Finow Canal. The results were last summer communicated to the Gesellschaft für Metallkunde and were published in two issues of the Journal of that Society (vol. xii, pages 340 to 358 and vol. xiii, pages 305 to 315).

Two main series of experiments were made on a 4-ton Amsler machine. In both the specimens were cylinders cut from rolled or compressed metal and heated to various temperatures, the cylinder dimensions being 36 mm. height and 18 mm. diameter. In the first series the work which was required to compress the specimen to half its height without giving rise to fracture, was determined; in the second series the compression was continued until fracture ensued, in order to determine the maximum compressibility.

Since it would have been very laborious to effect in all cases a reduction of 50 per cent. in the height of a specimen, this 50 per cent. value was determined diagrammatically. The Amsler machine was loaded with 10,000 kg. (almost all the specimens bore that pressure) which was sufficient for the desired height reduction without breaking; the test took about 20 seconds. The ram of the machine draws a pressure curve, an ordinate of 5 mm. being equivalent to 1,000 kg., and the abscissa corresponding to the reduction in the height of the specimen; from the area of the curve, measured in square millimetres, the work done in compression was deduced in metre-kilogrammes.

The specimen was placed in a cup-shaped steel vessel, having a bottom 20 mm. in thickness; a plate of the same material (Roechling R.A.E.3 steel) and the same thickness was placed on the top of the test cylinder; the vessel being sufficiently wide to admit of the flattening out of the specimen. The same cup was used for most of the experiments; it did not suffer at all, and Professor Heyn's objection that some reaction between the hot steel and the brass in contact with it might possibly affect the results, was tested and disproved by experiments in a special cup.

At first the specimen was heated in a furnace, maintained at the desired temperature for ½ hour, and then transferred direct to the machine. Then the specimen was heated within a cup turned out of shell steel in which it was packed with loose asbestos wool to keep heat losses down. That plan did not answer, however; cooling was still too rapid, and the asbestos got in the way. A simple electric furnace was therefore constructed which surrounded the first-mentioned cup with the specimen in it during the test.

This electric furnace was simply a piece of gas piping, 90 mm. internal diameter, which was coated outside with a paste of powdered firebrick and sodium silicate, and dried on a sand bath; three such coatings were superposed, and the pipe was then wound with chrome-nickel wire, the whole being finally inserted into a spacious cartridge case packed with powdered firebrick. This device answered; thermocouple and calorimeter measurements proved that the heat produced by the compression more than compensated for the heat lost by the specimen. The temperature of the specimen before compression was, for example, 500 deg. C., and after compression 520 to 543 deg. C. Similar figures for the experiments at temperatures below 500 deg. C. are not given in the report, and that seems to be a weak point in the research, since the heat of compression might play a relatively greater part at lower temperatures. Steam heating was adopted for the experiments at 100 deg. C.

The materials tested were: Compressed electrolytic copper; "tombak," rolled, containing 84·8 per cent. of copper, 0·05 per cent. of lead, 0·08 per cent. of Fe, the rest zinc (as in the other cases); special tombak rolled, 87·9 Cu, 0·14 Pb, 0·29 Fe; brass B 72, rolled, 70·96 Cu, 0·02 Pb, traces of Fe; brass B 67, rolled, 66·42 Cu, 0·19 Pb, 0·04 Fe; brass B 63, compressed rod, 62·09 Cu, 0·12 Pb., 0·04 Fe; brass B 58, compressed rod, 57·28 Cu, 0·39 Pb, 0·1 Sn; bronze, rolled, 98·82 Cu, 1·04 Sn, traces of iron (no zinc); condenser brass B 70, rolled, 68·18 Cu, 0·05 Pb, 0·78 Sn, traces of Fe, rest zinc

In the first set of tests the temperatures ranged from 500 deg. to 800 deg.; the curves then obtained were more uniform than those covering the whole temperature range from 20 deg. up to 800 deg. C. We reproduce the whole-range curves in Figs. 1 and 2. Both these diagrams indicate the work which had to be done on the specimen in order to reduce its height to one-half. The numbers 58, &c., mark the conventional designation of the average copper percentages, and the results are given in two diagrams, instead of in one, merely for the sake of lucidity. Curve 85 refers to the first tombak mentioned above. The special tombak, the bronze and the condensed brass B 70 were not tested below 500 deg. The special tombak differed little from the other, and the bronze little from copper.

The condenser brass gave at 500 deg. nearly the same value as tombak, but came down almost to the B 67 value at 800 deg. It would appear that for all

Fig.1.

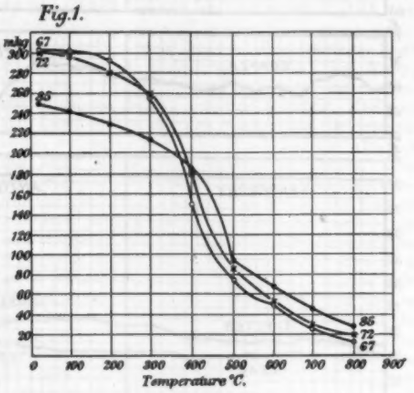
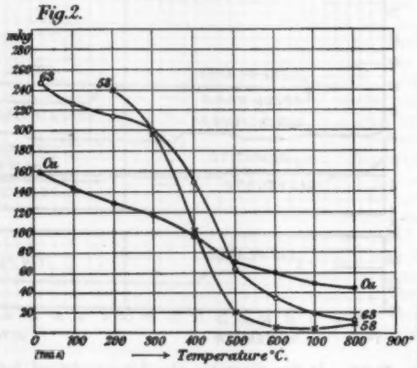


Fig.2.

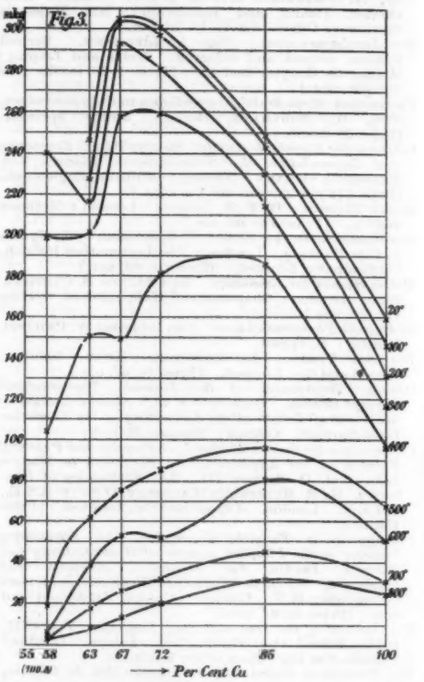


the brasses the resistance to compression diminishes rapidly between 300 deg. and 500 deg. and is lowest near 800 deg., possibly at a higher temperature; in the case of B 58 the minimum resistance is already reached at 700 deg., and there is not much change between 500 deg. and 800 deg. The photographs of the flattened buttons, reproduced in the original publication, show that the compressed cylinders were mostly sound; only in a few cases can marginal cracks be seen.

If we go a little further into particulars we notice that in copper itself the resistance to compression decreases regularly as the temperature is raised. In tombak the resistance falls off rapidly between 400 deg. and 500 deg., when the sense of curvature changes. In the brass B 72 the rapid decline sets in at 300 deg., in the brass B 67 already below 300 deg. In the curve of B 63 three portions may be distinguished of different senses of curvature. The brass B 58 could not be tested between 20 deg. and 100 deg., being too brittle, and there is a minimum resistance at 700 deg., as stated already. Above 500 deg. the alloys richer in copper require more work to be done to effect the same compression than the alloys less rich in copper; below 300 deg. this relation is reversed. That observation, it is pointed out, seems to contradict the technical experience that brasses B 72 and 67 can be more easily rolled and drawn in the cold than B 63; these operations depend mainly upon the resistance to reduction in cross-section, however, and involve the time factor. Plotting the work to be done in compression against the copper percentage of the alloy, Doerinckel and Trockels obtained the curves of Fig. 3. All these curves show a maximum. At low temperatures this maximum corresponds to 67 per cent. of copper. When the temperature of 300 deg. is exceeded, the maximum shifts over into the region of higher copper percentages, near 85 per cent. Though that point was not determined with sufficient accuracy, it is very striking that the curves, first irregular, become quite regular as the temperature of 500 deg. is reached. That indicates that the copper percentage is an important factor, as long as the resistance to compression is high, but that its importance vanishes at low compression strengths.

The second series of tests aimed at determining the maximum work that a brass can bear without undergoing fracture. The experiments were carried out by loading each specimen until it broke and by approximately ascertaining, with the aid of a diaphragm gauge, the pressure at which the specimen failed. The experiment was then repeated more cautiously with loads by 500 kg. or 1,000 kg. smaller than the breaking load, and the smaller load was accepted as the limit to be borne when it failed to produce fracture.

Fig.3.



The results could only be approximate since a specimen once strained nearly to fracture is no longer the original specimen. In this way it was found that copper may be compressed by 71 per cent. of its original height at 20 deg. and by 92 per cent. at 800 deg. The alloys gave less regular curves, the compressibility rising within the temperature range 20 deg. to 800 deg., from 55 per cent. or 60 per cent. to 75 per cent. and 85 per cent. The brass B 63 gave on the whole lower values than the others, especially at temperatures up to 500 deg.; the curve moreover showed a minimum of about 53 per cent. at 300 deg., which is missing in the other alloys. The curve of the brass B 58 is peculiarly irregular; it starts with a very low value, below 40 per cent. at 20 deg., and reaches its maximum of 80 per cent. at 700 deg., to decrease again; this latter observation thus confirms those of the first series of experiments.

Disregarding copper and tombak, which was also peculiar, Doerinckel and Trockels find that the temperature of 300 deg. generally marks the point at which the compressibility as well as the maximum pressure admissible distinctly increase with rising temperature. Discussing the general problems they suggest that the phenomena of the α range of brass are not yet quite cleared up, especially in view of the further experiments by Doerinckel and Max Werner (*Zeitschrift für Anorganische Chemie*, 115, pages 1 to 48) on the specific heats of the same alloys between 100 deg. and 800 deg. C. The specific heat of the untempered alloys, especially those low in copper, rises when a temperature of 470 deg. is reached; but this discontinuity vanishes when the alloys have been tempered at 800 deg. That would only partly agree with the researches of H. C. H. Carpenter and Edwards who first studied this discontinuity.

We should add that the specimens on which the compression tests above described were made were all tempered; but the mode of tempering adopted is not described in the report we have dealt with.

THE TREATMENT OF OIL EMULSIONS.

THE problems of the treatment, in the oilfields, of the emulsions of oil and water did not cause serious trouble in the early days of the Pennsylvanian oilfields, because most of these oils, of low density, are easily separated from water. The heavy oils of asphaltic base of California give troublesome emulsions, however, and almost any well may occasionally take to yielding an emulsion instead of a clear oil, though the working conditions may not seemingly have been altered. Emulsified oil is hardly marketable, and was formerly burnt under the boilers, if not actually allowed to run to waste. Serious general attempts at the recovery of emulsified oil were scarcely made till people came to appreciate the value of oil better during the war. The problem has often been touched upon in the meetings of the Institution of Petroleum Technologists, and was recently discussed by the Division of Petroleum Chemistry of the American Chemical Society in connection with five papers relating to oilfield practice. The oil can be recovered by mechanical, electrical and chemical methods, and the mechanical methods, both the oldest and relatively simplest, seem in general to be the best.

All the treatments aim at accelerating the settling. It was observed that exposure to the heat of the sun hastened the rate of settling, and "sunning" was therefore adopted. The effect being manifestly thermal rather than optical, heating by steam was resorted to, first in a crude way which involved loss of the volatile products, as in sunning. The steam coils must not be too hot, and closed pressure steam-coils are therefore inadvisable. The water in the emulsion, in contact with the hot pipe, would be evaporated and at once recondensed by the colder liquid, forming finer particles still less likely to settle than the original emulsion. According to Sydney Born, a modern steaming plant consists of five tanks. In the first tank the bottom settlings are heated up to about 150 deg. F. (122 to 160); the oil rises and overflows into the second and third tanks to be further heated, then to pass into the settling tanks. The process is continuous and proceeds for weeks without interruption. The centrifugal processes have been much developed of late. The machines resemble cream separators. A turbine bowl, 4·5 in. in diameter, is suspended by a vertical shaft running at 17,000 r.p.m. The oil is fed in from a tank, 30 ft. above the turbine, at a temperature of about 150 deg. F. The turbine is slowly started idle, and then charged with the salt water of previous operations before admitting the emulsion. The capacity of such a supercentrifuge ranges from 100 barrels to 300 barrels of oil per twenty-four hours. For heavy oils "topping plants" are recommended. These are pipe stills in which the emulsion is heated to 500 deg. F. maximum, to be passed through towers into condensers.

The difficulty of the various filtration processes is that they do little to promote coalescence of the oil drops. In the Hatschek filter the medium is calcium carbonate, which allows water, but not oil, to permeate; this process is efficient for removing oil impurity from water. Mixtures of vulcanised rubber and iron sulphide, on the other hand, let the oil pass. Kieselguhr is said to answer because the sharp needles of silica cut the oil films on the water globules, so that coalescence follows. The chemical methods facilitate coalescence by the addition to the emulsion of electrolytes, which are either supplied as solids (as tret-o-lite, which is essentially sodium oleate with a little resin and phenol) to be dissolved in water, or as oil-soluble liquids (sulphonated oleic acid). At the meeting mentioned R. R. Matthews and P. A. Crosby stated that the latter method had proved satisfactory in cases where centrifuging had failed; the treatment also requires heating, it should be mentioned.

The "wetted septum" of Cottrell is a kind of electro-endosmotic process. The septum, which is electrified, consists of canvas (cellulose), the open spaces of which are sufficiently large to let oil threads pass through, while water is absorbed. The objection to this system is said to be that the fine globules of oil are not brought to coalescence. More important is the other Cottrell process of electric de-emulsification by high-tension alternating currents. The treater is a steel tank, 8 ft. high, 3 ft. in diameter, in which a suspended shaft carries several disc electrodes, which are charged to 11,000 volts against the earthed cell, and are slowly rotated. The emulsion is fed in continuously at 140 deg. F. (up to 180 deg. F.) and settles in a trap tank into which it is delivered. This method is said to be largely in use in California. W. G. and A. C. Eddy estimated that 94 per cent. of the emulsified oil produced there is submitted to the Cottrell dehydration process, which is claimed to be generally applicable for the separation of one liquid from another. If the heat can be supplied by the exhaust from the compressor plant, that part of the cost would not amount to as much as they stated. But it will be noticed that none of the processes, except perhaps the chemical processes, admit of ready application in cases of emergency. Yet it is well known, as we have said already, that the emulsion trouble may set in suddenly and disappear again almost as suddenly. The modern tendency seems to be in favour of providing for this emergency. According to E. E. Ayres some 23,000 barrels of crude emulsion are now treated daily in the United States by 57 centrifugal plants.

THE HIGHER PRODUCTION COUNCIL.—The second annual meeting of the Higher Production Council was held on Tuesday last. Sir Samuel Waring presided, and it was stated that the Priestman system of payment, which the Council advocated, was now definitely adopted by 24 firms, while 17 others had adopted the scheme with certain modifications. Others who were favourable had not applied it on account of the unsettled industrial conditions.

CHROMIUM STEELS AND IRON.*

By LESLIE AITCHISON, D.Met., B.Sc., A.I.C.

THE extended use of alloy steels for general engineering purposes was almost synchronous with the firm establishment of the automobile industry. It is in fact extremely probable that the development of these steels owes more to the automobile industry and the aircraft industry than to all the other forms of commercial engineering. It seems to be highly appropriate, therefore, that the automobile industry should be kept as closely as possible in touch with all developments in connection with alloy steels, as the continued use of these steels appears likely to depend to a great extent upon the support given to them by automobile engineers. It is not suggested that chromium steels, possessing the composition and mechanical properties which render them suitable for incorporation in engines or structures, are an entirely novel development, but it is evident that the time is ripe for a careful presentation of the salient facts regarding these steels, because it is considered that steels containing chromium might be used much more extensively than is at present the case.

Since chromium steels are necessarily alloy steels, it would appear desirable to make, first of all, a brief examination of the real reasons which induce the engineer to use alloy steels in preference to carbon steels. Undoubtedly, in the first instance, engineers were attracted to the use of the alloy steels because of the high strength which could be obtained from such materials. After a fairly long and sometimes bitter experience of alloy

Fig. 1.

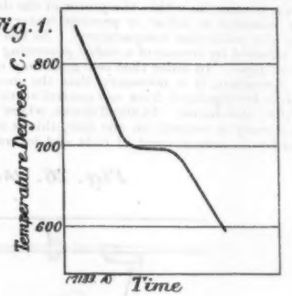
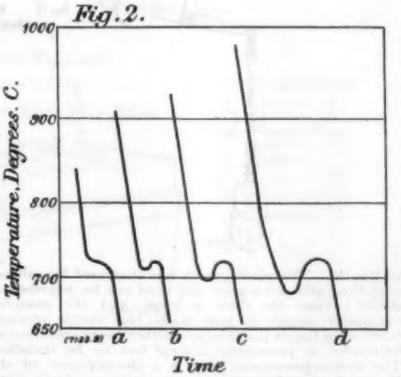


Fig. 2.



steels, it is probable that the average engineer is not so greatly enamoured of very high tensile materials as he once was, and that he has come to realise in very many circumstances the paradoxical truth that the stronger the steel the weaker is the part made from it.

Nevertheless the alloy steels are probably even in greater favour now than they were when their most obvious claim to respect was the high strength which they would provide. Probably this is due to the fact that it is possible to obtain an alloy steel of a given tensile strength which is very much more tough than the carbon steels of the same tensile strength. For many purposes toughness is now regarded as of greater importance than strength, and it is because the carbon steels are so frequently deficient in toughness that the alloy steels have their present vogue. This advantage is so great that the alloy steels are never likely to be ousted from the position which they now hold.

A further notable advantage, which the alloy steels present compared with the carbon steels, is found in the ease with which they can be hardened. This advantage is not particularly great in small parts, but engineering details of even moderately large dimensions are exceedingly difficult to harden when made in carbon steel. This is due to the "mass effect" in hardening. In works practice this means the difference between quenching a part in water or in oil, or even hardening it by cooling in air. Naturally, it is usually preferable to be able to cool a part fairly slowly for the purpose of hardening, as the slower a part may be quenched in order to harden it, the less danger there is of inefficient hardening and of irregular results, not to mention the danger of serious distortion.

* Paper read before the Institution of Automobile Engineers, on Wednesday, November 9.

The three main advantages, therefore, which can be presented by the alloy steels as against the carbon steels are:—

1. High tensile strength.
2. High toughness.
3. Ease in hardening and homogeneity in the resulting product.

The employment of alloy steels does not necessarily, however, produce nothing but advantages. There are some accompanying disadvantages. In the first place, the alloy steels are generally more costly than carbon steels. (This does not apply to every class of carbon steel or to every class of alloy steel.) Secondly, in consequence of the fact that the alloy steels will harden much more easily than the carbon steels, i.e., they will harden when cooled more slowly, it is found that they are more prone to the development of surface defects, which are produced during cooling either from the operations of casting, or forging, or drop-forging, or even during heat treatment. The higher tensile strength which is found in a large proportion of the alloy steels also renders them more difficult to machine, and this naturally considerably affects their economic value in engineering.

Since automobile parts are usually not of very large dimensions, it is clear that the need for a steel which hardens very easily and very drastically is not so great as it might be in other branches of engineering in which the masses of the parts are much greater. As a result it should be evident that there is comparatively little call (for any large proportion of automobile parts) for steels which harden to a high figure when cooled very slowly, such as truly air hardening steels. A steel which, when cooled in air, only hardens to a comparatively low value is quite satisfactory, as in the majority of such parts the steel can be rendered sufficiently and equally hard throughout the mass if it is cooled in oil.

Clearly then there is a premium to be put upon an alloy steel which possesses all the advantages of alloy steel, and at the same time possesses the disadvantages in the smallest degree possible. In other words, the most desirable automobile steel should possess the three cardinal advantages of the alloy steels, but at the same time should not be a steel which hardens drastically in the air, and should be a steel which can be machined fairly readily in the condition in which it can be usually supplied to the machine shop.

Reviewing the alloy steels which are at present available to the automobile engineer, it is evident that only comparatively few of those generally employed possess all the requisite properties in a moderately high degree. Almost all the nickel chromium steels (which, perhaps, represent the most widely employed class of alloy steel) harden to a notable degree when cooled in air, sufficient at any rate to cause difficulty in consequence of the hardening of the surface and the production of flaws. These steels always require to be softened to give a strength which is consistent with reasonably easy machining. The plain nickel steels, such as the 3 per cent. nickel steel of the B.E.S.A. Report No. 75, or of Air Board S.9 Specification, are likely to be reasonably satisfactory, and for the majority of parts provide most of the requirements. These steels, however, are more expensive than the corresponding chromium steel, and if the chromium steel can be shown to possess the various properties which are required by the automobile engineer in alloy steels, it clearly has an initial advantage over the remainder of such steels.

It is intended, therefore, to examine the chromium steels which might be available to the engineer in the light of the various properties which may be regarded as reasonable criteria of the value and usefulness of an alloy steel. It will be desirable, also, to make some reference to a property which is pre-eminently that of some of the chromium steels, namely, the resistance which these steels are able to offer to corrosion. In addition to resistance to corrosion, it is desirable to take into account resistance to scaling, where steels are being selected for valves. This, however, has already been done in the paper on "Valves and Valve Steels for Internal-Combustion Engines," read by the author before this Institution in November, 1919.* Stainlessness, or freedom from corrosion, is definitely an attribute of the chromium steels, and no other class of steel can present the same advantages. Certainly a 25 per cent. nickel steel is able to resist corrosion in a considerable measure, but this steel is costly, is somewhat arbitrary in its behaviour and not thoroughly reliable. In addition to these disadvantages, its mechanical properties are not of the same high order as are those of that group of chromium steels known as "stainless."

Before actually giving a description of the mechanical properties of chromium steels (which is naturally the most important information to the automobile engineer) it may be appropriate to give some brief account of the general effect which chromium exerts upon steels. A great deal of work has recently been carried out by various investigators upon chromium steels. This has been very largely directed towards determining the constitution of these steels, the influence of the various constituents which are found in them, and the constitutional changes which they undergo during various heat treatments. This information is of great value to the metallurgist, but in its present form is probably of very little use to the engineer. These investigations, therefore, will only be referred to in so far as the conclusions which have been reached are interesting to the automobile engineer.

Chromium is definitely one of those elements which are described as hardening constituents in steel. The addition of this element to steel has a general tendency

* See Proc. I.A.E., vol. xiv, page 31.

to raise the maximum stress of the material, and, consequently, its hardness, as generally understood. The extent to which the tensile strength is increased is a function not only of the chromium contents of the steel, but also of the carbon content. The various combinations of the two elements occur in a manner which is not easy to summarise, and it will probably be desirable to defer any detailed consideration of the effect of chromium until the numerous mechanical tests which have been made upon different chromium steels have been set out and scheduled.

It is generally known that the addition of alloying elements to steel has a distinct effect upon the critical temperatures of these steels, that is to say, upon the temperatures to which the steels must be heated in order that they shall become hard when quenched from that temperature. The effect of the presence of nickel in a steel is to lower its critical temperatures. The effect is most generally evident in the position of the critical temperature during cooling. For instance, if a 5 per cent. nickel case-hardening steel is heated up to a temperature of 860 deg. C. and then allowed to cool, it should theoretically (and in many cases practically) be hardened if it is quenched at any temperature higher than about 580 deg. C. A plain carbon steel would have to be quenched at not less than 720 deg. C.

The effect of the presence of chromium upon the corresponding properties of a steel is exactly the reverse. Whereas nickel lowers the critical temperatures, chromium raises them. The actual degree to which the critical points are raised depends upon the proportion of chromium in the metal. If, for instance, about 12 per cent. of chromium is present (as is the case in stainless steel) the material has to be heated to, and quenched from, a temperature higher than 825 deg. C. if it is to be fully hardened. This means that in the heat treatment of chromium steels the temperatures employed will be notably different from those used in the treatment of nickel steels, and also will be different from those employed in the treatment of carbon steels. The effect upon the hardening temperature, however, is not very great if the proportion of chromium in the steel is only quite small.

A further point in connection with chromium steels which requires careful consideration is that these steels are very susceptible to variations in the temperature from which they are cooled. In Fig. 1 an ordinary time-temperature cooling curve of plain carbon steel is shown. The horizontal portion of the curve corresponds to the changes which occur at the critical temperature. If the nickel steel is examined in the same way, the curve which is obtained is almost identical. If, however, a chromium steel is examined, the shape of the curve which is obtained in Fig. 1 is not always produced. A curve similar to that in Fig. 1 is obtained from a specimen which has been heated to a temperature not greatly in excess of the lower critical temperature. Such a curve is shown in curve *a*, Fig. 2. If, however, the same chromium steel is heated to a higher temperature and then allowed to cool, its cooling curve is different. Apparently the steel can be cooled to a temperature lower than its true critical temperature before the constitutional changes associated with that temperature take place. After the steel has been undercooled for a certain number of degrees, the constitutional changes do occur, and the temperature of the whole mass rises to the normal critical temperature. The shape of the curve in the region of the critical temperature is therefore S-shaped. A typical curve of this kind is shown in curve *b*, Fig. 2. The number of degrees by which the chromium steel can be undercooled depends upon the temperature to which it was heated before the cooling curve was started. If the temperature to which the steel is heated is still further raised, the number of degrees by which the steel can be under-cooled is also increased, as can be seen from the remaining curves *c* and *d* in Fig. 2. The temperature from which the cooling was commenced is shown on each curve.

Besides being influenced by the temperature from which the steel was cooled, the degree of under-cooling is also affected by the proportion of chromium and also by the proportion of carbon present in the steel. With a low proportion of chromium it is scarcely possible to obtain such a degree of under-cooling as might be helpful, but if the percentage of chromium is raised to, say, 6 per cent. or 7 per cent., then the number of degrees of under-cooling which can be obtained becomes so great that the constitutional changes are largely suppressed.

It is probably quite untrue to imagine that the presence of chromium, or of chromium and carbon, results in the lowering of the temperature at which the critical changes occur. This result is certainly obtained in the nickel steels, because it is possible in such steels to have proportions of nickel and carbon such that the resulting steel, however slowly cooled, does not give evidence of critical points, and therefore of constitutional changes, even down to room temperatures.

In the chromium steels the phenomena are different. When such a steel cools it will decompose at certain critical temperatures if sufficient time is given to it. The decomposition is a breaking up of the solid solution by the precipitation of specific substances. This breaking up involves the movement of particles, and therefore will clearly be influenced by the viscosity of the solid solution. The viscosity of the solid solution will become greater as its temperature is lowered, and it is quite easy to realise that, if a considerable degree of under-cooling takes place as a result of the presence of much chromium, the steel may have been cooled down so much that when the effect of under-cooling is exhausted, and the steel should normally undergo its critical constitutional change, the viscosity of the solid solution has become so high that this change cannot go forward. It is probably in this sense that the chromium steels are air hardening when they contain a sufficiently high percentage of chromium or of chromium and carbon. It is well known that whereas a nickel chromium steel will harden when cooled in air from the same temperature that would be employed for oil hardening the same metal, it is necessary, if the steel is to harden when cooled in the air, to heat a chromium steel to a higher temperature than would be employed for oil hardening.

One definite advantage that accrues from the raised hardening temperature of the chromium steels is that their tempering range is thereby widened. For plain carbon steels or for nickel steels the tempering temperature should not exceed about 650 deg. C. If it does, there is considerable danger, in works practice, of the steel being normalised and not merely tempered. This will, in most instances, result in a marked decrease in toughness. The chromium steels, however, may be tempered up to 700 deg., or even higher, with safety. This provides a margin of safety which in practice is often valuable.

(To be continued.)

THE MACHINERY OF FLOATING DOCKS.*

By E. H. Salmon, D.Sc., of London.

(Concluded from page 742.)

(2) Control.

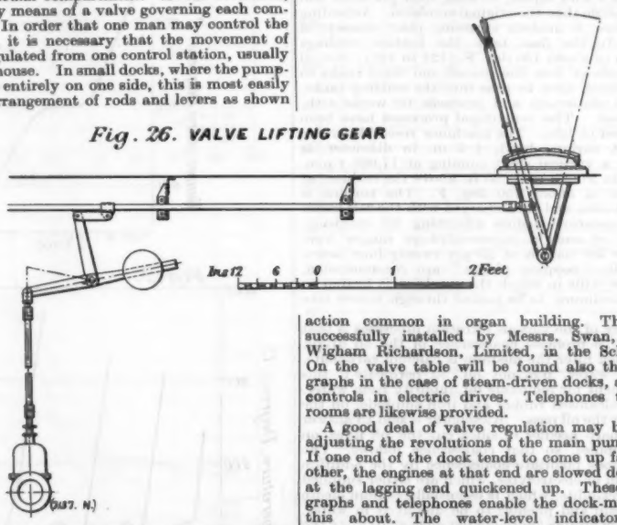
As has been pointed out, the problem of pumping a floating dock differs from that of a graving dock and similar cases, in that balance of the system has to be maintained while the pumping is proceeding. That is to say, it must be within the power of the dock-master at any moment to allow or prevent water entering or leaving any particular compartment. As has been seen, this is effected by means of a valve governing each compartment pipe. In order that one man may control the whole operation, it is necessary that the movement of the valves be regulated from one control station, usually called the valve-house. In small docks, where the pumping machinery is entirely on one side, this is most easily effected by an arrangement of rods and levers as shown in Fig. 26. The whole gear is like that used for railway signalling and point gear, and need not be described in detail. When the dock is large, and the pumping machinery occurs on both walls, this simple arrangement is no longer possible, and either electro-pneumatic, hydraulic or pnuematic control has to be installed. The electro-pneumatic gear is a development of the Westinghouse electro-pneumatic railway signal gear, and, as installed by that company, has worked very successfully. It is illustrated diagrammatically in Fig. 27. The valve rod is lifted by a pneumatic press, which is supplied with compressed air at about 5 or 6 atmospheres from an air receiver. The compressed air is supplied by Westinghouse pumps of suitable size, or otherwise as may be convenient. The connection between the valve-house and the press is electric. Contact is made in the valve-house by means of a suitable valve slide or switch, which results in the excitation of a small electro-magnet near the press. This magnet lifts a valve called the E. P. valve. As a result, the exhaust of the main press is closed, the inlet opened, and the air passes into the press, lifting the valve rod and opening the compartment valve. The area of the inlet valve is so proportioned that a suitable speed of lift is attained, usually about 15 seconds. The press remains in this condition until contact is broken in the valve-house when the exhaust opens, and the compartment valve is shut by a series of weights attached to the valve rod, which carry the valve rod and gates down to the closed position. The position of the valves, whether opened or closed, is indicated in the valve-house on small dials. These indicators are electrically operated, the movement of the press making and breaking contact by means of suitable contact breakers.

The current used is supplied by secondary batteries, or as otherwise convenient, at a pressure of about 10 volts or 12 volts. The air receiver is made of sufficient capacity that all the valves can be lifted and closed three times in 1 minute without reducing the pressure too much or successful operation. Wrought iron steam piping is used for the air mains. Should the compressed air or electricity fail during a lift, it might become necessary to operate the valves by hand. For this purpose a prolongation of the valve rod is carried above the deck, and through a nut operated by a hand wheel, Fig. 27. By this means the valve can be raised at pleasure independently of the compressed air.

When the electro-pneumatic system of valve operation is employed, the controls are arranged in the valve-house on a valve table. This table is made in the shape of a large model of the dock, and each compartment is indicated. Fig. 28 shows one-quarter of such a table. On the space representing each compartment is placed the valve slide or switch (shown in Fig. 28 as a rectangular box with a projecting angle), the indicator showing whether the valve is open or shut, and a gauge showing the height of water in each compartment. The dock master has thus the whole condition of affairs at every moment under his eye, and can make the necessary regulations with ease.

The hydraulic and pneumatic systems are very similar in operation, except that the medium transmitting the power is water under pressure in the one case, and compressed air in the other. The valve is lifted by a press as in the case of the electro-pneumatic system; the type used for the hydraulic system is shown in Fig. 29. In the valve-house the valve-control lever operates a two-way cock by means of which the supply pipe to the press is connected to pressure or exhaust as desired, causing the press to rise or descend as required. The details are simple, and work well. In the hydraulic transmission the necessary accumulator may be of the ordinary weighted type, or an air bottle half full of air works quite satisfactorily. The details of the pneumatic system are similar; the underlying idea is, in fact, exactly the same as the tubular-pneumatic action common in organ building. This type was successfully installed by Messrs. Swan, Hunter and Wigham Richardson, Limited, in the Schiedam Dock. On the valve table will be found also the engine telegraphs in the case of steam-driven docks, and the motor controls in electric drives. Telephones to the engine rooms are likewise provided.

Fig. 26. VALVE LIFTING GEAR



A good deal of valve regulation may be avoided by adjusting the revolutions of the main pumping engines. If one end of the dock tends to come up faster than the other, the engines at that end are slowed down and those at the lagging end quickened up. These engine telegraphs and telephones enable the dock-master to bring this about. The water-level indicators mentioned above are usually pneumatic. At the bottom of each compartment a cast-iron bell or inverted cup is provided, connected to the valve-house by a length of composition pipe. This pipe is joined on to a T-piece in the valve-house, one leg of which leads to a compressed-air reservoir. This branch has in it a valve, which, when opened, allows air to pass through the pipe and to bubble out of the bell at the bottom of the compartment. If the valve be now closed, the bubbling will cease when the pressure in the pipe and the bell is equal to the head of water in the compartment, and further, as the head increases or diminishes, so the pressure of the air in the pipe will rise and fall. To the third leg of the T-piece therefore, a pressure gauge is connected, graduated in feet and inches of height of water in the dock compartment. It is evident that this gauge will read the height of water in the dock compartments. As already mentioned, it is placed on the valve table in its appropriate compartment.

A variant of this arrangement is shown diagrammatically in Fig. 30. Compressed air enters through the valve V, which is capable of nice adjustment. It bubbles out of the tube shown at the bottom of the tube. The pressure necessary is regulated by the head of water H, and is measured by a mercury column in the valve-house, whose height h can be read on a suitably graduated scale. These pneumatic water-level indicators work reasonably well in practice, but are somewhat delicate in constitution. In a large dock there may be from 5 miles to 6 miles of the small bore tubing leading to the valve-house, the whole of which needs to be absolutely airtight, and leaks are very difficult to locate. Attempts have been made, therefore, at various times to use electrical means to replace the pneumatic systems. As a rule, the principle adopted is to cause variations in the water level in the compartments to increase or decrease the resistance of a wiring system. Electrical devices in the valve-house measure the altered resistance, and hence the head in the compartment. In other systems the movements of a float on the surface of the water are electrically transmitted to the valve house, and there registered on a dial.

The valve-house contains, in addition, apparatus for showing the amount of tip on the dock. The simplest

* Paper read before the Institution of Mechanical Engineers, on Friday, November 18, 1921.

form is an ordinary pendulum or plumb bob, or better still two, so arranged that one shows the amount of tip athwartships (list) and the other the longitudinal tip (trim). Continental makers usually fit indicators in the form of a cross-section or longitudinal view of the dock, as the case may be, mounted on a card and swinging on a horizontal axis, with a pointer passing over a dial. The pointer indicates the number of degrees of tip. In this country, two long sensitive spirit levels are mounted horizontally at right angles, thus indicating to the dock-master any want of level of the dock.

In long docks it is not unusual to fit some instrument to indicate the magnitude of the longitudinal deflection of the dock. It is evident that it is possible to keep the dock on an even keel and nevertheless to pump it very irregularly. For example, too much water might be taken from the end compartments and too little from those nearer the centre. Now a lifting power of well over 50 tons per foot run is quite common in large docks, and it will be obvious that very severe bending moments might be set up by injudicious pumping regulation. These bending moments would show themselves as a deflection of the dock, and it is often considered necessary that the dock-master should be able to form an estimate of this deflection while the lift is going on. Of the methods employed to effect this, optical means are probably the simplest and best. In the most elementary form a telescope is clamped on the side of the valve-house. At the end of the side wall a vertical post is erected in a line with the axis of the telescope. The top half of this post is painted white and the bottom red, the line of division representing a critical deflection beyond which it is not desirable to go. Provided, therefore, the post appears white through the telescope, the dock-master knows that he is safe.

A more scientific apparatus is shown diagrammatically in Figs. 31, 32 and 33. Here again the telescope (which is now capable of adjustment) is mounted in or on the valve-house. At suitable points along the side wall, posts are erected, each carrying a board painted white, with a horizontal black line across its middle. These boards are arranged fanwise in plan, Fig. 31, and increase in size proportionately to their distance from the telescope. In the case illustrated the valve-house is supposed to be at one end of the dock, and station IV at the other. The black lines are all carefully adjusted to the same level when the telescope is horizontal. Viewed from the eye-piece, therefore, Fig. 32, all these boards will appear side by side and of the same size, and if there be no deflection the black lines will appear as one continuous horizontal line, coincident with the hair line of the instrument. If, however, a deflection exists, some of the black lines will appear above or below the hair line, which is kept focussed on to the line of board IV. To measure its amount the fitting shown in Fig. 33 has been designed. The horizontal hair-line is made double, and the second line can be moved by turning the thumb-screw until it coincides with, say, the black line at station II. The amount of the deflection there is read off on scale II on the dial, which is graduated in inches or millimetres of deflection, and similarly for the other stations.

(3) AUXILIARY MACHINERY.

Fire and Wash-down Service.—As has been remarked earlier in this paper, it is difficult completely to empty the water from the pontoon compartments by means of the main centrifugal pumps. For this purpose a reciprocating pump is desirable. Further it is necessary in all important docks to have hose connections for the purpose of washing down the ship in dock or for fire extinction. These functions are combined in the fire and wash-down pumps shown in Fig. 34. The type of pump usually used is that made by Messrs. Hayward-Tyler and Co., Limited. The steam cylinders are placed

Fig. 27. DIAGRAM OF ELECTRO-PNEUMATIC VALVE CONTROL GEAR.

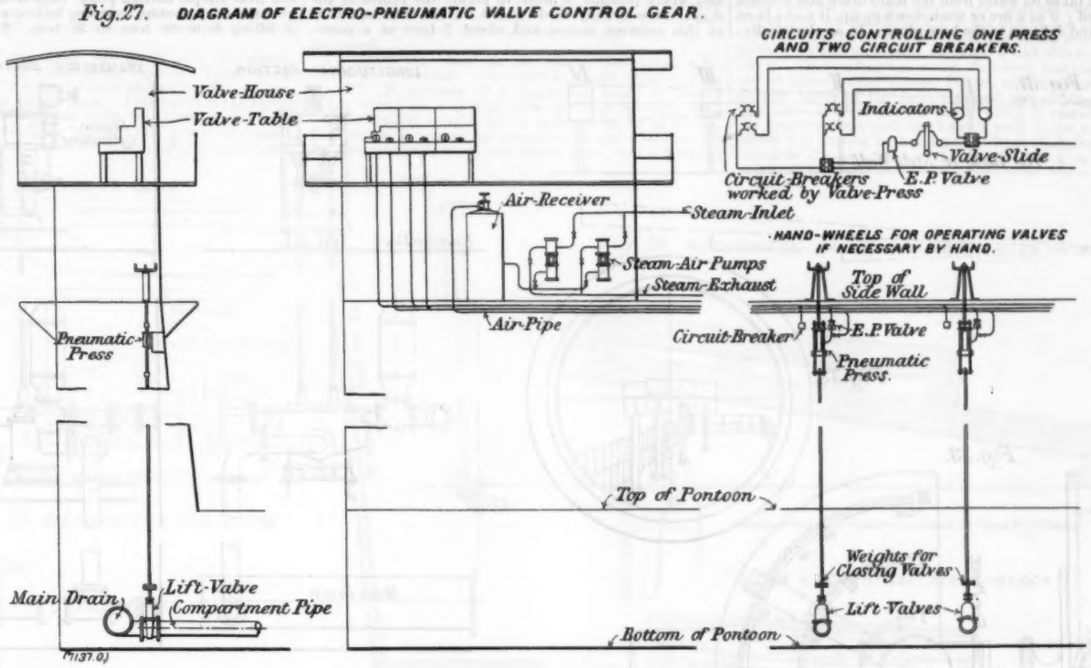


Fig. 28. VALVE-TABLE

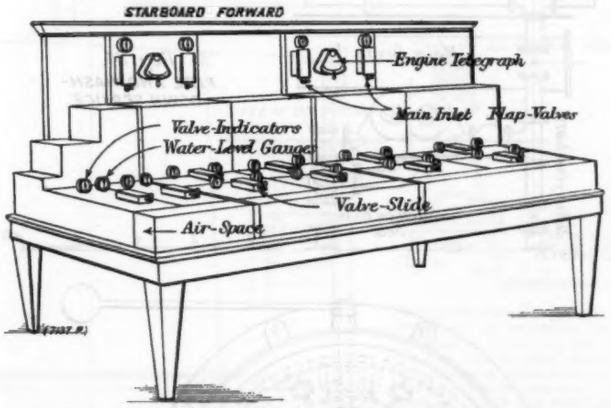


Fig. 29. HYDRAULIC VALVE LIFTING PRESS.

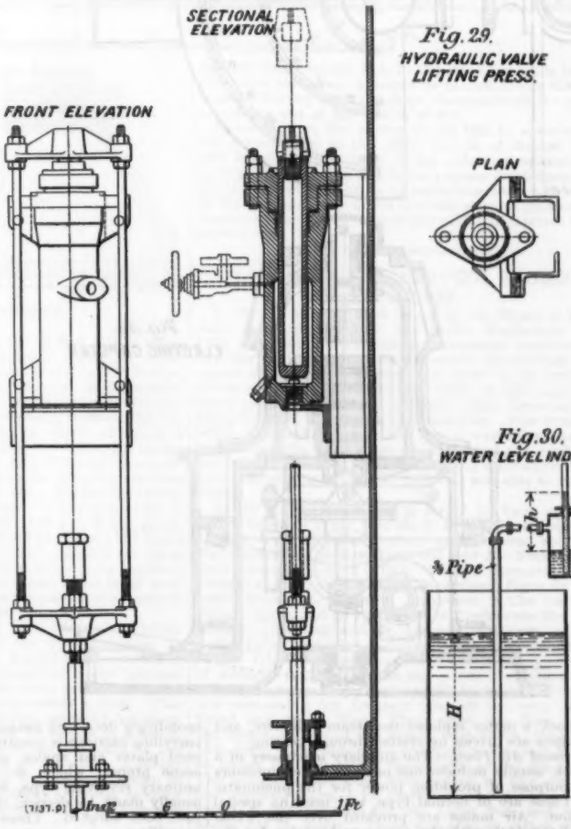
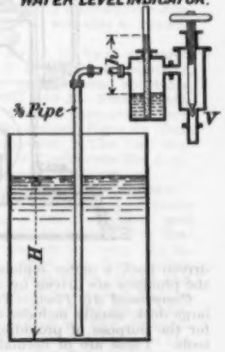


Fig. 30. WATER LEVEL INDICATOR.



on the engine deck, the pumps proper at some convenient place below. The pump is arranged to suck either from the main drain or the sea as desired, and to deliver either to a horizontal pipe on the face of the wall from which hose connections branch at intervals, or overboard to the sea. If the pump is required as a drainage pump, it takes its water from the main drain and delivers overboard; if as a fire or wash-down pump, it sucks from the sea and delivers to the hose pipes. In an electrically-driven dock a motor replaces the steam cylinders, and the plungers are driven by cranks through gearing.

Compressed Air Plant.—The auxiliary machinery of a large dock usually includes one or more air compressors for the purpose of providing power for the pneumatic tools. These are of normal type, and need no special description. Air mains are provided over the whole length of the dock with the necessary branches for the hose connections.

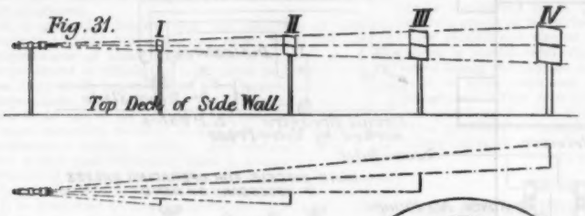
Electric Lighting Machinery.—This machinery is the usual type common in ships, that is, a high-speed steam engine direct-coupled to a continuous current dynamo on the same bedplate. A fairly low voltage is usually adopted. The same or similar machines are sometimes employed to work the capstans and cranes when these are electrically driven. They also supply power for the electric drills and other machine tools.

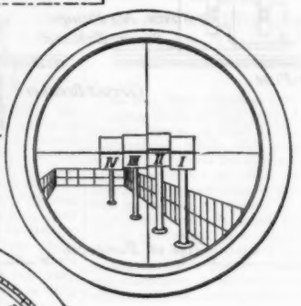
Cranes.—The cranes used in floating docks are of two varieties: (*a*) The travelling type, mounted on a four-legged carriage; and (*b*) fixed or console cranes. The travelling crane runs along the top of the side wall, and where possible is made to plumb the centre of the dock. It is usually made to lift from 2 tons to 3 tons at this extreme radius, and about 5 tons at a correspondingly decreased distance. The travelling carriage is constructed of steel plates and angles, with the crane proper, which is of the ordinary revolving type, fixed on the top. The jib is usually made to derrick, though hammer-headed types have been adopted. These cranes are, of course, self-propelling.

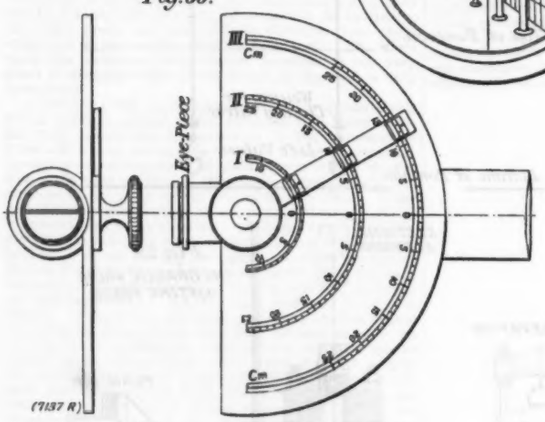
Both steam and electric drives are employed. With the lighter loads the hoisting speed may be from 15 ft. to 25 ft. per minute, revolving speed 50 ft. to 60 ft. per minute, and travelling 40 ft. to 60 ft. per minute. The steam cranes are usually self-contained, that is to say, they carry their own boiler. The electric cranes are fitted with collector gear, the conductors running along just below the top deck level. Alternatively, studs or a wandering lead may be employed. In small docks hand cranes are sometimes fitted.

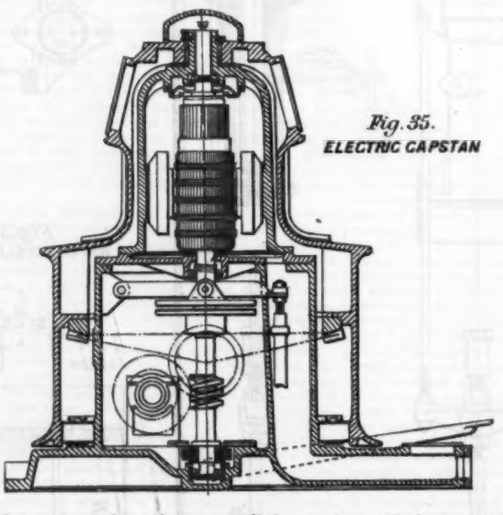
The fixed or console cranes consist of a swinging derrick or jib provided with suitable guys for slewing it and holding it in position. These cranes may vary in size from simple derrick poles, used to lift light weights from the dock or ship, to strong lattice-work jibs capable of lifting from 20 tons to 30 tons. These latter are sometimes provided at the ends of important docks to deal with propellers and shafting, &c. Blocks and falls are attached to the head of the jib, and arrangements are usually made whereby the dock's capstans may be utilised for hoisting.

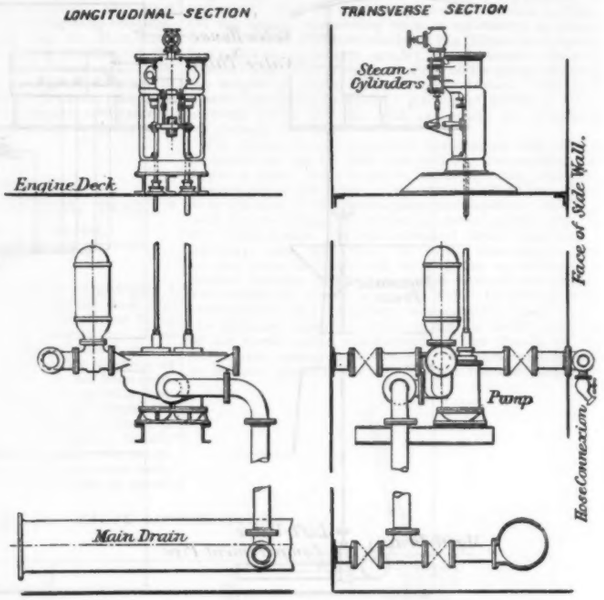
Distilling, Heating and Ventilating Machinery.—In large naval docks, evaporators and distilling condensers are fitted for the purpose of providing drinking water for the crews. A similar plant can be installed for supplying fresh water for the dock boilers where necessary. For cold climates steam heating apparatus is provided











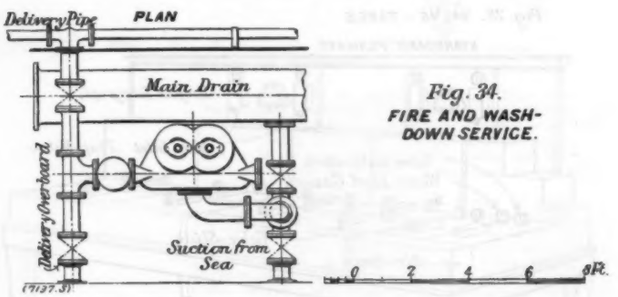
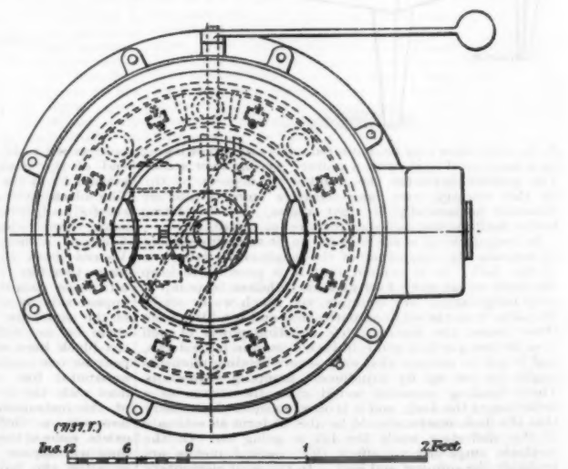


Fig. 34.
FIRE AND WASH-DOWN SERVICE.



capable of maintaining a temperature of from 50 to 60 deg. in the living and machinery rooms when there are 20 deg. of frost outside. The same steam installation can be utilised to thaw the water pipes and valves in the pontoon, which is necessary in very cold climates. Ventilation is maintained by air pipes, hatchways, &c. Electric fans are provided wherever necessary to ventilate the condenser and other low-down rooms, as is usual in ship practice.

Workshops.—Large docks are fitted with workshops, and are capable of undertaking repairs. These workshops are either arranged inside the side walls, or outrigged from the upper deck. This latter is the better plan where possible. The tools fitted are of the type common in shipbuilding yards. The power is usually electric. As in the case of the main pumping machinery, these workshop tools may be carried on a separate pontoon. Such a floating workshop was installed in connection with the floating dock at Durban.

Fig. 36. LEADING-IN GEAR.

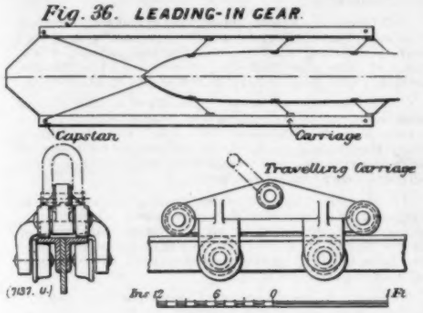
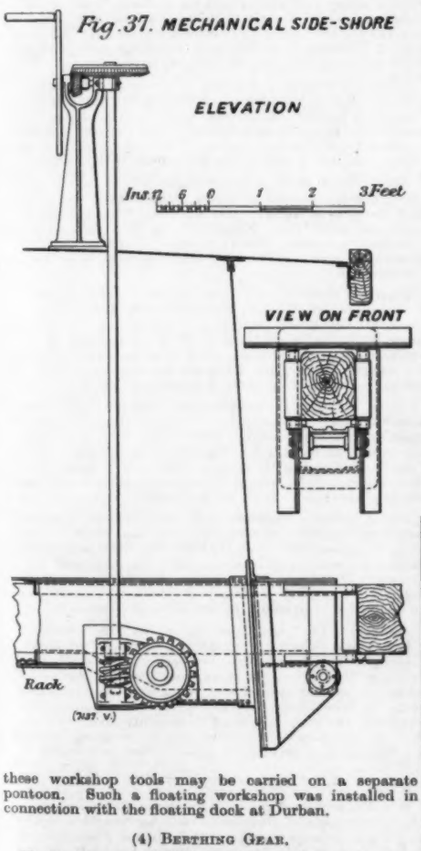


Fig. 37. MECHANICAL SIDE-SHORE



(4) BERTHING GEAR.

The berthing gear includes all the machinery necessary to haul the vessel into the dock, to centre her on the blocks, and to hold her there during the period of the docking. The most important items are the capstans. These may be hand, steam or electric. The nicest form is undoubtedly the electric capstan standing entirely upon the top deck, thus avoiding the expense of special capstan rooms. A neat design by Messrs. Clarke, Chapman and Co., Limited, is shown in Fig. 35. This capstan is capable of exerting a pull of 3 tons at a speed of 60 ft. per minute, the current required being 40 amperes at 440 volts, direct current. For steam docks, or where a much bigger pull is required, steam capstans are used. The capstan barrel stands on the top deck, and the engines in a capstan room below. Suitable bollards and fairleads are, of course, provided.

An arrangement adopted in large docks to facilitate the entrance of ships, which is called the leading-in gear, is shown in Fig. 36. Over the whole length of both walls near the top a projecting tee-bar is arranged, which forms a run-way for the small carriages shown. The ship is attached to these carriages by lengths of chain arranged diagonally as indicated in the plan. As the ship moves forward, the carriages slip along the run-way, but sufficient directive effort is exerted to guide and steady the ship until she is in dock. A series of chains and carriages are used, attached at suitable intervals to the vessel.

To centre the vessel on the blocks mechanical side-shores are provided. One type is shown illustrated in Fig. 37. It consists of a horizontal beam of timber which works in a special tube piercing the side wall. To this timber is attached a rack driven by a pinion. This pinion is rotated by means of a hand-wheel on the top deck through bevel and worm gear. On the top of the timber shore is painted a scale in feet. It is easy, therefore, by adjusting the opposite shores to equal readings to ensure the ship being centred on the blocks. In some docks these shores are moved mechanically. A continuous shaft driven by an electric motor runs the full length of the side wall. Above each shore on the top deck is a post and hand wheel, by means of which a clutch is operated. When it is desired to move the shore, the clutch is thrown into gear, and the shaft operates the rack driving gear. The drive is reversible so that the shore may be moved in or out. Hydraulic shores have also been used with success. A hydraulic ram is used to move the shore in and out, but a rack and pawl, or some such similar device, is fitted to prevent the shore running back should the pressure fail. Shores are often made double, that is, two similar shores moving together are fitted one directly below the other. The inner ends of the horizontal timbers are then connected by a vertical fender, which is sometimes of the roller type.

Fig. 38. MECHANICAL BILGE-SHORE.

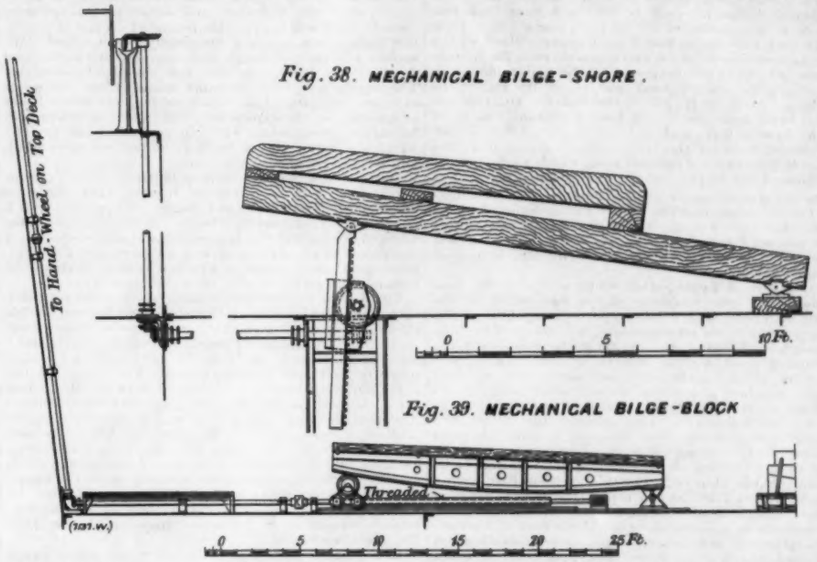
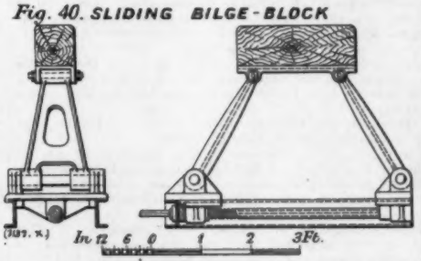


Fig. 39. MECHANICAL BILGE-BLOCK

Fig. 40. SLIDING BILGE-BLOCK



Mechanical bilge-shores have been adopted in many docks, particularly in those of the off-shore type, to support the bilges of the ships. A good type is shown in Fig. 38. The shore proper is a transverse timber pivoted near the centre of the dock. The outer end is connected to the top of a vertical strut which carries a rack. This rack is driven by means of a pinion operated by worm and bevel gear from the top deck by means of a hand-wheel. By these means the shore can be raised to the right height to support the bilge of the ship. A spring timber is provided on the top of the shore as shown in the figure. This is allowed to deflect a certain amount before coming in contact with a stop, thus giving a certain amount of extra elasticity.

A second type of mechanical bilge-shore is shown in Fig. 39. Here the pivoted shore is made of steel, and its lower surface is curved as shown. This lower surface rests on a three-roller carriage, which is moved across the deck by means of a long square-threaded screw operated through gear from the top deck. The curved under surface acts as an inverted inclined plane, and the inward movement of the carriage causes the shore to rise to the desired height and inclination.

A third type of mechanical bilge-shore or block is shown in Fig. 40. A channel-iron frame resting on the deck carries links forming a four-bar motion. The top link is a flat plane carrying a timber block which supports the bilge of the ship. The lower link is a square threaded screw carried in bearings by the channel-iron frame. Of the two vertical links the lower end of the inner one is pivoted to the frame, the lower end of the outer one is pivoted to the crosshead carrying a nut driven by the screw. By rotating the screw, therefore, the bilge block can be raised to any desired height, and it automatically adjusts itself to the inclination of the ship's bottom. The screw is rotated by a shaft, which is carried across the pontoon deck and up the side wall to the top deck, where it is turned by hand gear. This shaft for a considerable distance across the pontoon deck is square, and fits into a square hole in the screw, which is hollow. The bilge block can therefore be moved across the deck to suit different widths of ships, the square shaft entering or coming out of the hollow screw.

In conclusion, the author would like to acknowledge his indebtedness to the office records of Messrs. Clark and Standfield for much of the information contained in this paper, and to thank the various firms mentioned for their kind permission to reproduce certain drawings as illustrations. He hopes that the account given of the machinery used in floating docks will be of interest to the profession.

LOW-PRESSURE HEATING BOILER EXPLOSION.

A REPORT has just been issued by the Board of Trade under the provisions of the Boiler Explosions Acts 1882 and 1890, of a formal investigation conducted at the City Police Court, Minshull-street, Manchester, with regard to the circumstances and cause of an explosion which occurred on October 27, 1920, at the paper and fancy goods warehouse of Messrs. Abel Heywood and Sons, Limited, Lever-street, Manchester. One man, the boiler attendant, was killed, and a warehouseman who was passing the boiler room at the time of the explosion, was injured by shock and scalding, but after some detention and treatment at the hospital was able to resume work.

At the formal investigation Mr. G. C. Vaux appeared for the Board of Trade, and Mr. F. Brocklehurst, barrister, instructed by Messrs. Crofton and Craven, solicitors, Manchester, for Messrs. Heywood and Mr. Frank Platt, their managing clerk; Mr. William Rousseau, their electrician, and Mr. William Anderson, formerly their boiler attendant, appeared in person. The Commissioners appointed by the Board of Trade were Mr. A. A. Hudson (presiding) and Mr. Arthur J. Maginnis.

The boiler was what is known as the "Rockingham" saddle type, for low-pressure heating. It was made of wrought iron, welded at the joints throughout, and was 72 in. long, 37 in. high and 31 in. broad. The fire-box containing the firegrate was 68 in. long, 24 in. broad and 18 in. high. There were two flues within the upper portion of the boiler, each 24 in. broad and 5 in. deep. The upper flue returned to the back end, to an outlet 12 in. diameter, through the top of the saddle. The horizontal flat sides were stayed by five wrought-iron screwed stays, $\frac{7}{8}$ in. diameter, placed between the crown of the fire-box and the lower flue, and spaced about $11\frac{1}{4}$ in. apart. There was also on either side of the fire-box, between it and the flat sides of the boiler, a row of short stays, similar in number, size and spacing. The crown of the fire-box was flat, with a good curve at each upper corner, and the crown of the boiler shell was curved. The thickness of the plates throughout appears to have been intended for $\frac{7}{16}$ in., but the actual thickness measured at the torn edge varied from $\frac{5}{16}$ in. to $\frac{6}{16}$ in.

The boiler mountings consisted of two cast-iron screw-

down flow valves, each 3 in. diameter, placed on the top of the saddle; from these, cast-iron branch pipes, each 3 in. diameter, were led. One of these was fitted with one 3-in. diameter and two 2-in. diameter branches, the other had two 3-in. diameter branches. Each branch was fitted with a corresponding diameter, cast-iron, screw-down stop valve, which connected to the ranges of pipes leading to the various parts of the building. At the back, on the lower part of the boiler end plate, a 5-in. diameter cast-iron screw-down stop valve was fitted, and a cast-iron branch pipe, 5 in. diameter fitted with flanges, to which the five cast-iron screw-down type return valves were secured. Three of these valves were 3 in. diameter, and two of 2 in. diameter, corresponding in numbers and size to the flow valves. There was a deadweight relief valve, $\frac{11}{16}$ in. diameter, placed on the top at the front end of each boiler. These were of special design for such boilers, and were loaded to relieve at a pressure of 51 lb. per square inch. Each boiler feed water pipe was $\frac{3}{4}$ in. diameter, fitted with a $\frac{3}{4}$ in. diameter screw-down valve placed near the bottom on the side, near the front end of the boiler, and connected to the supply tank placed on the top of the building, about 80 ft. above the boiler. On the side of the latter feed pipe, in the lowest position, was fitted a $\frac{3}{4}$-in. branch pipe, and screw-down stop valve for the purpose of draining the boiler. The outer end of this pipe was fitted with a screwed plug, which would have to be removed before the boiler could be emptied.

The name of the makers was Messrs. Newton Chambers and Co., Limited, and the age of the boiler at the time of the explosion was about five years. No repairs had been executed and the boiler was not insured, but was inspected by Colonel Heywood and by Mr. Rousseau, the firm's electrician.

At the formal investigation which occupied four days in May last, considerable evidence was called by the Board of Trade, and in the report just published the history of the boiler arrangements, the system of heating, the method of feeding and draining, the question of the attendance paid to the boilers by the stokers and engineers at the works, &c., are dealt with at great length, covering a term of several years. The Commissioners, after describing the boilers and their fittings proceed as follows: "The scheme for which the heating arrangements were designed required the subdivision of the heating pipes into sections, so that the pipes in any portion of the building not required to be heated could be shut off. For this purpose there were a series of valves fitted at the top of the boilers between headers. Each header connected the two boilers, and the connection to each boiler was by a cast-iron screw-down valve 3 in. in diameter. From one of these headers three cast-iron flow pipes were led, and from the other header two such pipes. There were, therefore, five flow pipes, each with a valve; and there were also five return pipes, each with a valve, besides the valves connecting the headers with the boilers. The return pipes were all connected with one header, also joining the two boilers together, and this header was connected with each boiler by a 5-in. diameter screw-down stop valve. In additon to these valves there was, on a separate $\frac{3}{4}$ in. diameter feed-pipe to each boiler a $\frac{3}{4}$-in. diameter screw-down valve, and on these pipes next each boiler was another $\frac{3}{4}$-in. valve, and a branch pipe for the purpose of draining the boilers. Altogether there were 18 valves of various sizes. After the explosion all these valves were found to be closed, and this Inquiry has chiefly been directed to the circumstances connected with these valves in an effort to ascertain who it was who closed them.

"About the end of 1915 the apparatus was set to work, and a man named Anderson was placed in charge of the stoking. He was in no way skilled, and his duties were limited to stoking the boiler. Colonel Heywood the deputy-chairman of Messrs. Abel Heywood and Sons, interested himself considerably in this heating installation, and having some engineering training he adjusted the flow and return valves so as to regulate the heating of the different sections, and gave definite instructions to the man Anderson to 'Let these valves alone.' A man from Messrs. Matthews and Son, heating engineers, also told Anderson that the valves on the top of the boiler connecting the headers with each boiler must not be interfered with, and that on no account was he to touch any one of the return valves. Colonel Heywood took great precautions as to these valves; he wrote on a slate, which was hung up in the boiler-house, the number of turns which each valve was to be set at in order to secure a proper flow and return in the different sections."

The report deals with various matters in full detail, and states that Anderson left for the war in July, 1916 and did not return until March, 1919. He alleged that he emptied both boilers and admitted having closed 10 of the valves and the two fixed valves besides: that is 12 valves out of the 18 which were found closed after the explosion. According to the evidence of Messrs. Heywood's staff no one had any idea but that the boilers were in their normal condition, full of water, and ready to be set to work when the cold season set in. For various reasons another man named Yates was appointed to take charge of the boilers in Anderson's place on August 25, he was not skilled, and his duties were confined to stoking and cleaning out the fires. On October 20, it being presumed that all was in order, the fires were lighted, but died out later in the day. On October 27 they were again lighted at a quarter to ten in the morning, and before eleven o'clock a violent explosion took place so severely injuring the man Yates, who was in charge, that he died shortly after his removal to the hospital. Upon a careful examination of the boilers being made it appeared that the crown of the fire-box of the left-hand boiler had ruptured at the weld, and the line of the rupture as it left that spot went through the plate. The crown of the right-hand boiler was pocketed to the extent of fully 3 in. for practically the whole length. Mr. Moroney, the engineer-surveyor to the Board of Trade, informed the court that when he first made his examination he inquired of everyone who had seen the boilers after the explosion, and he was assured that the whole of the 18 valves were found closed. Each witness who appeared before the Commissioners also stated that each valve which he was able to examine was closed.

Three skilled witnesses who examined the boiler, unhesitatingly stated that the cause of the explosion was shortness of water. These were Mr. Moroney, Mr. Stones (assistant engineer to the National Boiler Insurance Company), and Mr. Matthews (one of the firm who designed the apparatus). In their report the Commissioners say: "We have no doubt that this was the cause, having regard to the condition of the boiler plates after the explosion, and as all the valves were closed, there was no possible means of escape of steam, the boilers being each a completely-closed vessel. We should add that although Anderson stated that he had emptied the boilers he had not completely done so. The result was that probably about 12 in. of water or more (owing to a leak in the valves) was in the boiler at the time of the explosion. This water would rapidly be turned into steam, while the crown of the fire-box which the water did not reach would become overheated, and thus the explosion occurred."

With regard to the responsibilities of the various parties the court exonerated Messrs. Abel Heywood and Son, Limited, from any blame. They employed a good firm of engineers (Messrs. Matthews and Sons, Limited) to install the apparatus, and also employed a competent staff, and there was no necessity, the Commissioners say, to engage a skilled person to stoke the fires and generally to look after the apparatus.

Further the Commissioners add that they did not think that they could hold Messrs. Matthews and Son responsible though the court were making certain recommendations. As to Mr. Rousseau (Messrs. Heywood's electrician), the Commissioners say that he performed his duties properly and was not to blame. The cause of the explosion, the report states, rested between Mr. Frank Platt (Messrs. Heywood's managing clerk) and William Anderson, between whom there was an almost complete conflict of testimony. "If," the Commissioners say, "Anderson told Mr. Platt that the boilers had been emptied, which involved the closing of important valves, and Mr. Platt allowed an unskilled man to set the installation to work again without skilled supervision, he would be clearly culpable, but in view of the unsatisfactory evidence of Anderson they could not hold Mr. Platt responsible."

In regard to Anderson, his conduct and the evidence which he gave before the Commissioners, "leave," they state, "in their own mind the strongest suspicion that he was either directly or indirectly the cause of the explosion, and of Yates losing his life. There is not, however, sufficient evidence to enable us to say that he was to blame. They expressed their deep sympathy with the relatives of Henry Yates, who lost his life in this explosion."

In conclusion the Commissioners say: "In the hope of avoiding such explosions in the future, and as a warning to those who have such installations in use, we should state that in our opinion no such installation should be set up or maintained in use unless either it is fitted with a steam escape pipe carried from the highest point of the boiler, or at least one circuit pipe is left open to the atmosphere without any valve whatever." This is the only practical way, the Commissioners say, of avoiding explosions, from such causes as they had been inquiring into. The report closes by giving a list of 12 questions put to the Commissioners by Mr. Vaux on behalf of the Board of Trade with regard to the circumstances and cause of the explosion, and the responsibility of the various persons concerned. To these, full replies are given, and the court made no order as to costs.

Society of Glass Technology.—A meeting of the Society of Glass Technology was held in the Fuel Department, the University, Leeds, on Wednesday, November 16, 1921, at 2.30, the president, Dr. Morris W. Travers, F.R.S., in the chair. Following the demonstration by Mr. F. W. Knowles of an "Improved Gas Reversing Valve for Regenerative Furnaces," the meeting resolved itself into a discussion of problems connected with "The Melting of Glass." Members had been invited to send in questions for discussion, the following being considered: (1) What effect had the weight and volume of batch filled on, and the period of time elapsing between fillings upon, the rate and efficiency of melting? (2) What was the better practice to adopt in filling on batch in a glass tank, to fill on a large quantity at considerable intervals or small quantities more frequently? (3) What was the effect on selenium decolouriser of having saltcake present in the batch? (4) Trouble had been experienced with dark specks in actinic green glass. Chromium oxide was used. What could be done to get this colour and avoid the dark specks? (5) It has been sometimes noticed that metal in the tank appeared to be quite plain and after a few hours further boil had developed. What was the cause of this, and what could be done to prevent it? (6) On the subject of the casing of opal on flint glass, trouble was at times found in the cracking of the glass after manufacture. What were the special points to be observed so as to carry out the process successfully? (7) If a seger cone be made from a glass by grinding and moulding, was there any relation between the squatting point of the cone and the founding and plaining temperatures of the glass? The questions elicited interesting discussions in which several members took part.

CATALOGUES.

Welding.—A small pamphlet from Messrs. Barimar, Limited, 10, Poland-street, London, W. 1, contains illustrations and descriptions of welding repairs to motor car engine cylinders, radiators, crankshafts, lamps and other parts.

Oil Engines.—A careful description of all the working parts of their high compression oil engines, from 13 b.h.p. to 62 b.h.p., with tables of shipping weights, is given in a catalogue issued by Messrs. Norris Henty and Gardners, Limited, 115, Queen Victoria-street, London, E.C. 4.

Drawing Pencils.—A small book of line drawings indicating the various grades of pencils used for drawing work, issued by Alpco Pencils, Limited, 173, Lower Clapton-road, London, E. 5, will be of interest to draughtsmen.

Mill Gearing.—Messrs. David Bridge and Co., Limited, Castleton, Manchester, send a 60-page catalogue of mill gearing including shafting, bearings and pulleys, reduction and other gears, friction clutches, &c. The clutches are fitted to a great variety of drives and machines.

Crane Control.—A useful explanation of the control equipment for electrically-driven cranes is given in a catalogue section received from Mr. George Ellison, Perry Bar, Birmingham. It is intended to be of service to persons in charge of electric cranes, whether fitted with this firm's control gear or not.

Air Heating.—Appliances for heating air for various purposes, and especially the combustion air for boiler furnaces, are described in an interesting catalogue of Messrs. Emile Prat-Daniel Company, Limited, Paris, sent to us by their London representative, Mr. S. Utting, 82, Victoria-street, S.W. 1.

Packing.—A great variety of gland packings suitable for all steam and water pressures in metal, asbestos, rubber, hemp and other materials is shown in an 80-page catalogue issued by the Beldam Packing and Rubber Company, Limited, 29, Gracechurch-street, London, E.C. 3. Belting, jointing, valves and kindred products for engineering use are also fully represented.

Electrical Fittings.—Revised lists of prices for fittings and switch gear have been issued by the General Electric Company, Limited, Kingsway, London, W.C. 2, together with a list of recent additions to their low-tension and medium-tension switch gear. The apparatus is now being exhibited at the firm's new offices in Kingsway.

Sheet Metal Work.—A catalogue of oil storage and other tanks, ventilating piping, ship tanks, oil switch and transformer tanks, steel shelving, bins and similar work, to hand from Messrs. G. A. Harvey and Co. (London), Limited, Woolwich-road, London, S.E. 7, illustrates some very fine examples of sheet-metal construction.

Electric Welding.—An arc process and apparatus for fusing together metal parts are described in catalogues received from Messrs. Handstock, Limited, 2, Harewood-place, Oxford Circus, London, W. 1. Examples of the applications of the process, which is particularly suitable for repetition work, are the fixing of a stud or a piece of tubing on to plate or other flat surface.

Tubes.—A very comprehensive list of cold drawn seamless steel tubes and of a large variety of special machine and constructional parts made from such tubes has come to hand from the Perfecta Seamless Steel Tube and Conduit Company, Limited, Plume-street, Birmingham. The tables of weights in pounds per foot for all dimensions of tubes are included.

Power Plant.—Examples of their boilers, engines, condensers, turbo blowers, ejectors and other power-house equipment are illustrated and described in a special catalogue issued by Messrs. Daniel Adamson and Co., Limited, Dukinfield, Manchester, for the purpose of indicating the economy in power production which can be effected by installing the latest improvements.

Injectors.—The catalogue issued by the National Injector and Ejector Company, Limited, Chell-street, Longsight, Manchester, may be specially commended for its clear illustrations of types, and also for the useful tables of capacities and the particulars of renewable parts it contains. Special types of injectors for stationary, railway and road, boilers are dealt with, as also are appliances for filling tanks, creating vacua, and forcing acid or other liquids. Prices are stated.

The Argentine Fencing and Wire Rope Trade.—The Department of Overseas Trade has issued a report which has been prepared by the Buenos Aires Branch of the Anglo-South American Bank, Limited, on the market for fencing material and wire rope in the Argentine Republic. The report will be found of interest by British manufacturers and merchants of these specialities in future business with Argentina; but at present the market is overstocked and there is very little demand now for wire for fencing purposes. It should be noted, however, that in regard to wire rope, its importation into the Argentine Republic is relatively small. In the matter of freight rates, agents of British manufacturers complain, the report states, of the difference between the freight rates obtaining from British and from other ports. The present rates are, from San Francisco 14 United States dollars (gold), from the United Kingdom 80*s.*, and from Germany 25*s.* In some cases, therefore, it is advantageous to send goods from a British port to Hamburg or Antwerp, in transit to Buenos Aires. This illustrates one of the serious difficulties now facing our home industries.